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THE
NERVOUS SYSTEM
OF THE
HUMAN BODY.

LONDON:
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THE

NERVOUS SYSTEM

OF THE

HUMAN BODY.

EMBRACING

THE PAPERS DELIVERED TO THE ROYAL SOCIETY ON THE
SUBJECT OF THE NERVES.

BY CHARLES BELL, F.R.S.

LONDON:
PUBLISHED BY LONGMAN, REES, ORME, BROWN, AND GREEN, PATERNOSTER-ROW;
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1830.

MAG. 3-6

TO

THE KING.

Sire,

When the exultation, into which the Nation had been carried by the triumphs of your Majesty's arms, had subsided, it was seen that your Majesty, comprehending justly what belonged to the reign of a great Prince, had not been unmindful that "Peace has her victories no less than war." Thus have the times, under your Majesty's auspices, been as remarkable for the progress of science, the accessions to literature, and the embellishments of architecture and the arts, as for great naval and military achievements.

Your Majesty's sense of the importance of the cultivation of the sciences to the state is evinced by the honours placed by your Majesty at the disposal of learned societies. May I be permitted to express how much gratification these honours afford, and how well they are suited to fulfil your Majesty's gracious intention of exciting emulation, and rewarding exertion in the pursuit of knowledge.

The permission to inscribe this volume to your Majesty, demands the gratitude of

Your Majesty's

humble and devoted subject,

CHARLES BELL.

PREFACE.

The account of the nervous system given in this volume was originally presented to the Royal Society in six papers, which will be found in their Transactions from the years 1821 to 1829. Four of these papers were republished under the title of The Exposition of the Nervous System; and some time after an Appendix was given to the public, containing cases in illustration.

In the period immediately preceding the publication of these papers in the Philosophical Transactions, there was a singular indifference to the study of the nerves; and an opinion very generally prevailed, that as the notions of the ancients had descended to us uncontroverted and unimproved, the subject was entirely exhausted. The hypothesis that a nervous fluid was derived from the brain, and transmitted by nervous tubes, was deemed consistent with anatomical demonstration, and there was no hope of improvement.

Most of the points of anatomy which have directed my inquiries had been noticed by Dr. Alexander Monro, in his work on the Nervous System. It was he who discovered that the ganglions of the spinal nerves were formed on the posterior roots, and that the anterior roots passed the ganglions. Santorini and Wrisberg observed the two roots of the fifth pair of nerves. Prochaska and Sœmmerring noticed the resemblance between the spinal nerves and the fifth pair, and they said, why should the fifth nerve of the brain, after the manner of the nerves of the spine, have an anterior root passing by the ganglion, and entering the third division of the nerve*?

I do not believe that this approach to the knowledge of the true anatomy of the nervous system, made by these celebrated men, will at all diminish the reader's satisfaction on perusing this volume. He will see that the efforts of those who followed them were still undirected by any principle, and that the multiplicity of anatomical facts which continued to be discovered by the anatomists of Europe only added to the intricacy of the subject. Paletta described the anterior root of the fifth nerve, and tracing it to the muscles of the jaw, conceived it therefore to be a muscular nerve*. But did this observation diminish the intricacy of the nervous system, or add to it? For example, Paletta, after the discovery of these branches of the fifth pair to the muscles of the jaw, and just as one would expect that he was about to expound the truth, adds, that for the other branches of the fifth nerve he does not know what to make of them! So that he who really knew the detail of this part of anatomy most perfectly, was most confused.

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* Although the course of my investigations has not been directed by the suggestions of anatomists, yet it is curious to observe how much importance may be now given to passages which heretofore had little interest attached to them.

Prochaska concludes his essay on the Structure of the Nerves with this remarkable passage: " Quis rationem dabit: quare nam nervorum funiculi tam in sua crassitie quam in miris suis plexibus ac concatenationibus per totum suum decursum ludant? Quare radices anteriores nervorum spinalium ganglia spinalia insalutata transeant, et quare nam solæ posteriores radices ganglia spinalia trannare cogantur? Et cur radices nervorum spinalium anteriores ramosæ in medullam spinalem inserunter, aut, si mavis, ex ea medulla oriuntur, dum interim posteriores radices funiculos teretes non ramosos complectuntur? Quare omnium cerebri nervorum solum quintum par post ortum suum, more nervorum spinalium, ganglion semilunare dictum facere debet, sub quo peculiaris funiculorum fasciculus ad tertium quinti paris ramum, maxillarem inferiorem dictum, properat insalutato ganglio semilunari ad similitudinem radicum anteriorum nervorum spinalium? Et plura alia in structura nervorum occurrentia proponi possent, quorum ratio sufficiens reddi nondum potest: attamen utrum unquam reddi poterit, desperandum esse minime videtur, verum liceat interim ea lactari spe, quam tritum proverbium (*dabit dies quod hora negat*) haud raro non vanam fuisse ostendit."—*Prochaska, de Struc. Nerv.* 1779.

Sœmmerring, when discussing what were the probable uses of the ganglions, says, " Quæ causa est, cur in radice posteriore tantum nervorum spinalium ganglia inveniuntur, minime autem in priore. An priore nervorum spinæ medullæ radice, et minori quinti nervorum paris portioni novo hoc virium augmento non opus est?" —*Sœmmerring, de Corp. Hum. Fab.* Tom. iv.

It will appear in the text, that after struggling with the difficulties in the demonstration of the nerves of the body for many successive years, I had recourse to their origins to find out their uses. I first took a view of the spinal nerves in all their course, and observed their exact resemblance to each other in every particular. I then by experiment proved that their roots had different powers, and that they really were what their anatomy had indicated to me, double nerves. Strengthened in my conviction that the anatomy, if properly pursued, would bring symmetry out of confusion, I set about the examination of the nerves of the encephalon, and found that the fifth nerve of the brain was the only one which could bestow upon the

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[*] He saw the branches *crotophiticus* and *buccinatorius*, which he considered to be voluntary nerves, and to be the cause of trismus.

head, that which was given to the body through the spinal nerves. I then selected the nerves of the face for experiment, to demonstrate to others what I had convinced myself of, by anatomy. Had I commenced with experiments, they would have misled me; I should have supposed the fifth nerve to have been the nerve of sensibility, and the portio dura the nerve of motion. All I wished was to make a sufficient impression on those who had resigned all hope of a definite issue to the investigations of nerves. I had before determined that the fifth was a double nerve, a nerve of motion as well as a nerve of sensation; and that the portio dura of the seventh was more than a muscular nerve, that it belonged to the respiratory system, and that this was the reason of its running apart from the fifth.

Facts connected with this subject multiply every day, and now, owing to the knowledge of the general system, its arrangement, and the functions of the different roots, they assume an order, instead of adding to the former confusion. To show how little the grand features of the nervous system were known, and how necessary system was to the comprehension of details, I shall add some further illustrations. It had been asserted by our English physician, Johnstone, that ganglions were for the purpose of cutting off sensation. Monro on the contrary conceived that they did not cut off sensation, for they were attached to nerves which he knew to be muscular nerves! "That ganglia," he says, "do not serve to render motions independent of our will, as an ingenious author (viz. Johnstone) has supposed, is evident, without observing more than that all the branches of the fifth pair, and the posterior half of all the spinal nerves of the voluntary muscles, pass through ganglia*." If I had only ascertained that this was not true, and that no motor nerve from the head to the heel passes through a ganglion, the observation should have been received with more show of interest.

The celebrated Scarpa dwells with great minuteness on the ganglions of the spinal nerves and the double origins of the nerves, and he puts the question—why should the posterior root have a ganglion? "Is the posterior root," says he, "a proper and peculiar kind of nerve, belonging exclusively to the spinal marrow, whilst the anterior root is a cerebral nerve?" Thus we see that notwithstanding the knowledge of minute anatomy, the observation standing in this shape carries no force with it, and leaves the system doubly confounded. The elegant plates of the nerves of the throat and thorax by this author, and the cases in illustration of the affections of the ninth nerve, have proved the highest source of satisfaction and improvement to me. And yet these nerves, as represented by Scarpa, may convince the reader, as the class dissection was wont to impress me, that our notions received from the ancients were quite inapplicable and unsatisfactory.

What better proof can be afforded of the utter confusion which prevailed than the explanation of Sœmmerring,—that many small nerves were equivalent to one larger, and that this was the reason of there being three nerves given to the tongue; or that of Monro, that there were two nerves given to the face, lest by the accidental division of one, the face should be deprived of nervous power altogether? This was the authority for the surgeon making so free with the nerves of the face in the case of tic douloureux. He divided them, confiding in the opinion that if one nerve of the face were cut, the remaining nerve would bestow both sense and motion, though in a diminished degree. Such, then, was the state of opinions previous to the first paper given by me to the Royal Society; nor is it surprising that whilst these contradictory notions prevailed, our physicians should look upon the nervous system with despair of finding any satisfactory result to direct their practice. The practical benefit to be derived from these investigations is, not only that the physician shall discover distinct systems of nerves to be the seat of disease, but he shall acquire new powers of discriminating symptoms, as I hope may be shown by the cases in the Appendix.

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* Monro's Plates of the Nerves, page 55.

Immediately after the publication of these papers, attempts were made both in France and at home to deprive me of whatever merit was attached to them. From the indifference so long evinced to such investigations before these communications to the Royal Society, I conceived that I should have been permitted in a slow, temperate, and scientific manner, to have stated the whole of my observations to that learned body. This, however, became difficult, not only from the attempts made to anticipate my conclusions, but also because in the further prosecution of the subject it became necessary to introduce medical cases. The present mode of publication admits of those professional illustrations which appear to disadvantage in the philosophical transactions, which should be open to general science only.

It was owing to a mere accident that my opponents did not succeed, by the mere reiteration of assertions, in these attempts, which would have been attended with this disadvantage to science—that as they hastened to anticipate my conclusions, before they themselves comprehended the system, or knew on what secure foundation and long experience it rested, they had almost thrown the whole subject into doubt, and into worse confusion than had prevailed before. Whilst one gentleman summed up his conclusion by supposing that the fifth pair of nerves was the nerve of sensation to the face, and the seventh a voluntary nerve; another physiologist had, in addition to my observation of the fifth being a double nerve, added that it was the nerve of all the senses!

H. Mayo ?

Magendie

These mistakes arose from undervaluing the subject, and mistaking the method of investigation, conceiving that it was possible without a careful examination of functions, by an experiment merely, to come to the right conclusion. As soon as the principle was ascertained that nerves had different functions according to the divisions of the brain and spinal marrow, from which they took their origin, all the rest followed of course; it required only to study the functions of the organs and the nerves supplying them, to prove which nerve ministered to each distinct function. Had any physiologist meant to assist me in this part of the investigation, good sense, which so often answers the same end with right feeling, should have dictated an acknowledgment of the principle on which he was proceeding.

It was fortunate that after having been engaged in the investigation of the nervous system for some years, and finding interminable labour before me, I thought of taking the opinion of my friends, and of exposing my notions to their criticism, lest I should uselessly expend all my leisure on an unprofitable subject. It was with this purpose that I printed a little work in 1811, which I entitled, "*An Idea of a new Anatomy of the Brain, submitted for the Observation of the author's Friends.*"

I do not know that I could introduce the subject with a more appropriate preface, after twenty years' familiarity with the investigation, than is in that little work. The following passage will show how early and how uniformly I have held the same language, and how happily my anticipations have been fulfilled.

"The prevailing doctrine of the anatomical schools is, that the whole brain is a common sensorium; that the extremities of the nerves are organized so that each is fitted to receive a peculiar impression; or that they are distinguished from each other only by delicacy of structure, and by a corresponding delicacy of sensation; that the nerve of the eye, for example, differs from the nerves of touch only in the degree of its sensibility. It is imagined that impressions, thus differing in kind, are carried along the nerves to the sensorium, and presented to the mind; and that the mind, by the same nerves which receive sensation, sends out the mandate of the will to the moving parts of the body.

"It is further imagined that there is a set of nerves, called vital nerves, which are less strictly connected with the sensorium, or which have upon them, knots cutting off the course of sensation, and thereby excluding the vital motions from the government of the will.

"This appears sufficiently simple and consistent, until we begin to examine anatomically the structure of the brain and the course of the nerves; then all is confusion: the divisions and subdivisions of the brain, the circuitous course of nerves, their intricate connexions, their separation and reunion, are puzzling in the last degree, and are, indeed, considered as things inscrutable. Thus it is, that he who knows the parts the best is most in a maze; and he who knows least of anatomy sees least inconsistency in the commonly received opinion.

"In opposition to these opinions I have to offer reasons for believing, that the cerebrum and cerebellum are different in function as in form; that the parts of the cerebrum have different functions, and that the nerves which we trace in the body are not single nerves possessing various powers, but bundles of different nerves, whose filaments are united for the convenience of distribution, but which are distinct in office, as they are in origin, from the brain:

"That the external organs of the senses have the matter of the nerves adapted to receive certain impressions, while the corresponding organs of the brain are put in activity by the external excitement; that the idea or perception is according to the part of the brain to which the nerve is attached; and that each organ has a certain limited number of changes to be wrought upon it by the external impression:

"That the nerves of sense, the nerves of motion, and the vital nerves, are distinct through their whole course, though they seem sometimes united in one bundle; and that they depend for their attributes on the organs of the brain, to which they are severally attached.

"The view which I have to present will serve to show why there are divisions and many distinct parts in the brain; why some nerves are simple in their origin and distribution, and others intricate beyond description. It will explain the apparently accidental connexion between the twigs of nerves; it will do away the difficulty of conceiving how sensation and volition should be the operation of the same nerve at the same moment; it will show how a nerve may lose one property and retain another; and it will give an interest to the labours of the anatomist in tracing the nerves."

I have to add, that, after making several experiments on the cerebrum and cerebellum, I laid the question of their functions entirely aside, and confined myself to the investigation of the spinal marrow and the nerves; a subject which I found more within my power, and which forms the substance of the present volume.

So much has been said about a French physiologist anticipating my observations, that I will here transcribe from the little work quoted above, my opinions of the functions of the spinal marrow, and the distinct offices of the anterior and posterior roots of the spinal nerves in 1811.

"In thinking of this subject, it is natural to expect that we should be able to put the matter to proof by experiment. But how is this to be accomplished, since any experiment direct upon the brain itself must be difficult, if not impossible? I took this view of the subject; the *medulla spinalis* has a central division, and also a distinction into anterior and posterior fasciculi corresponding with the anterior and posterior portions of the brain.

" Further, we can trace down the crura of the *cerebrum* into the anterior fasciculus of the spinal marrow, and the crura of the cerebellum into the posterior fasciculus. I thought that here I might have an opportunity of touching the *cerebellum*, as it were, through the posterior portion of the spinal marrow, and the cerebrum by the anterior portion; to this end I made experiments, which, though they were not conclusive, encouraged me in the view I had taken.

" I found that injury done to the anterior portion of the spinal marrow convulsed the animal more certainly than injury to the posterior portion; but I found it difficult to make the experiment without injuring both portions.

" Next, considering that the spinal nerves have a double root, and being of opinion that the properties of the nerves are derived from their connexions with the parts of the brain, I thought that I had an opportunity of putting my opinion to the test of experiment, and of proving at the same time that nerves of different endowments were in the same cord and held together by the same sheath.

" On laying bare the roots of the spinal nerves, I found that I could cut across the posterior fasciculus of nerves which took its origin from the posterior portion of the spinal marrow without convulsing the muscles of the back; but that on touching the anterior fasciculus with the point of the knife, the muscles of the back were immediately convulsed.

"Such were my reasons for concluding that the cerebrum and cerebellum were parts distinct in function, and that every nerve possessing a double function obtained that by having a double root. I now saw the meaning of the double connexion of the nerves with the spinal marrow; and also the cause of that seeming intricacy in the connexions of nerves throughout their course, which were not double at their origins.

"The spinal nerves being double, and having their roots in the spinal marrow, of which a portion comes from the cerebrum, and a portion from the cerebellum, they convey the attributes of both grand divisions of the brain to every part, and therefore the distribution of such nerves is simple, one nerve supplying its destined part. But the nerves which come directly from the brain come from parts of the brain which vary in operation; and in order to bestow different qualities on the parts to which the nerves are distributed, two or more nerves must be united in their course, or at their final destination. Hence it is that the first nerve must have branches of the fifth united with it: hence the portio dura of the seventh pervades every where the bones of the cranium, to unite with the extended branches of the fifth: hence the union of the third and fifth in the orbit: hence the ninth and fifth are both sent to the tongue: hence it is, in short, that no part is sufficiently supplied by one single nerve, unless that nerve be a nerve of the spinal marrow, and have a double root, a connexion (however remotely) with both the cerebrum and cerebellum.

"Such nerves as are single in their origin from the spinal marrow will be found either to unite in their course with some other nerve, or to be such as are acknowledged to be peculiar in their operation.

"The eighth nerve is from the portion of the medulla oblongata* which belongs to the cerebellum; the ninth nerve comes from the portion which belongs to the cerebrum: the former is a nerve of the class called vital nerves, controlling secretly the operation of the body; the latter is the motor nerve of the tongue, and is an instrument of volition. Now the connexions formed by the eighth nerve in its course to the viscera are endless: it seems no where sufficient for the entire purpose of a nerve, for every where it is accompanied by others: and the ninth passes to the tongue, which is already profusely supplied by the fifth.

"Understanding the origin of the nerves in the brain to be the source of their powers, we look upon the connexions formed betwixt distant nerves, and upon the combination of nerves in their passage, with some interest; but without this the whole is an unmeaning tissue. Seeing the seeming irregularity in one subject, we say it is accident; but finding that the connexions never vary, we say only that it is strange, until we come to understand the necessity of nerves being combined in order to bestow distinct qualities on the parts to which they are sent. From the crura cerebri, or its prolongation in the anterior fasciculi of the spinal marrow, go off the nerves of motion. But with these nerves of motion, which are passing outward, there are nerves going inwards; nerves from the surfaces of the body; nerves of touch; and nerves of peculiar sensibility, having their seat in the body or viscera. It is not improbable that the tracts of cineritious matter which we observe in the course of the medullary matter of the brain are the seat of such peculiar sensibilities; the organs of certain powers which seem resident in the body." In this extract there is much which has been rejected from the present volume, as inconsistent with mature reflection, or incapable of proof; yet the principle which has guided me is distinctly announced.

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* "The medulla oblongata is only the commencement of the spinal marrow."

When the first paper was written for the Royal Society, the facts to be collected from books, or ascertained by what occurred in practice, were so few, and yet so important, that they were admitted into the body of the dissertation. But in the time that has elapsed since the first publication of these papers, cases have so multiplied upon me, and have been so liberally communicated, that they cannot now be given to the public as part of the original essays, without overloading the subject and introducing intricacy. Besides, these cases being now illustrated by a better knowledge of the anatomy, they assume a new importance. Formerly the symptoms, which are both regular and of easy explanation, were thought to be irregular and accidental. They were classed as *nervous* symptoms, which was another way of saying that the physician was not expected to investigate or explain them. For these reasons the cases are in this edition thrown into an appendix, and occasional comments upon them enable the reader to enter upon some new inquiries without distracting his attention from the study of the body of the work.

Whatever may be thought of the course of reasoning pursued in this volume, the facts admit of no contradiction: and perhaps, hereafter, curiosity may be excited to know in what manner they were first received. The gratification in the inquiry has been very great: the reception by the profession has been the reverse of what I expected. The early announcement of my occupations failed to draw one encouraging sentence from medical men. When the publication of these papers by the Royal Society made it impossible to overlook them altogether, the interest they excited drew countenance on those who opposed them, or who pretended to have anticipated them. To myself this has ceased to be of consequence; but I confess, I regret to leave those young men who have honourably and zealously assisted me in these inquiries*, in the delusive hope of labouring to the gratification of their own profession—the pleasure arising from the pursuit of natural knowledge, and the society of men of science, must be their sufficient reward.

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* I am indebted to a pupil for this note.

The following was the order of communications to the public, on those investigations of the Nervous System, which were carried on openly in Mr. Bell's theatre, and taught in his lectures.

The "Idea of a new Anatomy of the Brain," &c., was printed in 1811.

In Dr. Cooke's work, published 1821, the opinion of Mr. Bell that the different functions of the nerves in the same bundle depended on their roots, is referred to.

In March, 1821, these experiments on the spinal nerves, which are detailed in the " Idea of a New Anatomy of the Brain," were performed by Mr. John Shaw, before the pupils. An account of these is to be found in the " Medical and Physical Journal" for October, 1822. The notes of Mr. Cæsar Hawkins, then a pupil, descriptive of these experiments, distinctly show, " that upon irritating the posterior roots of the spinal nerves in three or four places, no effect was produced upon the neighbouring muscles; but when the anterior roots singly, or the whole spinal nerve, was pinched by the forceps, or pricked by the scissors, an evident motion was produced on the muscles, not only perceptible to the eye, but, when the third or fourth dorsal nerve was touched, the whole scapula moved in the hands of the assistant. This motion was not communicated to the muscles when the ganglion, which is formed on the posterior root within the sheath, was touched; neither did it follow an injury of the posterior column of the spinal marrow." " The motion given to the muscles was not the slight tremulous motion arising from the natural irritability still remaining in them, but it was convulsive and spasmodic, and followed each successive prick of the scissors."

In July, 1821, Mr. Bell's first paper on the Arrangement of the Nerves, &c. was read to the Royal Society.

In the same month, Mr. John Shaw, in his " Manual of Anatomy," explains Mr. Bell's system, the distinction of the spinal nerves, the similarity of the fifth nerve to them, and the peculiar office of the seventh. The volume is accompanied with the two plans, to be found in the present work.

In December, 1821, Mr. Shaw wrote a paper on the Facial Nerves in " Brande's Journal of Science." In this he stated, that at the request of M. Magendie he had repeated Mr. Bell's experiments on the face of a horse, at *Charenton*, near Paris; and had, at the same time, presented a copy of the " Manual" above mentioned to M. Magendie.

The papers by Mr. Shaw, in the " Quarterly Journal," and the " Medico-Chirurgical Transactions," on Partial Paralysis, were given in March and April, 1822.

One part of the paper in the Medico-Chirurgical Transactions is introduced by this title:—" Why should Sensation remain entire in a limb when all Voluntary Power over the actions of its muscles is gone? or, Why should Muscular Power remain when Feeling is gone?" To explain this question, an extract, containing the account of Mr. Bell's experiments on the spinal nerves, is taken from the " Idea of a new Anatomy of the Brain," and reference is made to other experiments which confirmed their results.

It was after all this (in July, 1822) that M. Magendie published his paper on the Nerves of the Spine. On its arrival in this country, M. Magendie was informed that these experiments on the Spinal Nerves had been performed in Great Windmill-street, which he acknowledged in his next journal, with the addition, that, although Mr. Bell had preceded him, his own proofs were more complete. Unfortunately, however, M. Magendie advanced a little more than enough, by saying, that the anterior roots had a slight degree of sensibility as well as motion; this last error is a necessary consequence of his mode of conducting his experiments. We have heard Mr. Bell repeatedly state at lecture, that the impossibility of arriving at a decided conclusion regarding the sensibility of these roots, was the reason why he left his experiments as we find them, to prosecute the subject by observations and experiments on the fifth pair. By these experiments he ascertained that the fifth was a double nerve, the nerves of mastication and of common sensibility: and this was before M. Majendie had published on the subject of the nerves at all.

The Nervous System formed a considerable part of Mr. Bell's lectures, which were delivered in two courses annually. When we attended in Windmill Street, the concourse, when this subject came round, was very great; and it was illustrated by even a greater variety of facts and observations than we find in his published works.

INTRODUCTION.

FIRST PART.

I.

When the nerves of the human body are fully displayed, by a dissection pursued for two or three months on the body preserved in spirits, there appears inextricable confusion. The same irregularity is visible on the perusal of good engravings of the nervous system, such as those of the celebrated Scarpa, the most distinguished anatomist of our time. But if two or more bodies should be dissected with the same patience and dexterity, we find that if we lift a thread of nerve, and observe its connexion in one body, the second and the third bodies will have a similar thread, with just such connexions as in the first. If we trace one, two, or three nerves distributed to one organ in the first body, just so many nerves, and in the same order, will be found in the second and the third bodies. If we pick out a small ganglion in the one, it seems like a thing of chance until we find a similar ganglion, in the precise same spot, with exactly the same twigs of connexion, in all the bodies. In all the dissections we make, there are the same joinings and branchings of the same number of nerves; and we perceive the exactness of resemblance just in proportion to the care with which the preparations are made. No thinking person can avoid coming to the right conclusion here. At first this intricate net-work seems accidental; there appears neither arrangement nor system: but when the anatomist finds a perfect resemblance in all those bodies; when the minute twig discovered at Pavia or Berlin is as surely found by the anatomist in London as the astronomer abroad traces in the heavens the discoveries of Herschel; there can be no longer a doubt of the nerves being distributed with regularity and system.

II.

The term irregular may be applicable to arteries and veins, because it signifies not whether a part be supplied by this or that branch of the aortic system; arterial blood will be supplied, whether it comes from the right hand branch or the left. But the seeming irregularities of the nervous system ought not to be considered as such; the error is in our mode of proceeding; either the dissection has not been minutely prosecuted, or we have thought that mere contact was a union of the branches of the nerves. It will be proved that the property dispensed through them results altogether from the source from which the nerve is derived, and that one nerve cannot supply the office of another. There is no such thing as a nerve deviating or being wanting, (an occurrence frequent in the vascular system), without the loss of some essential faculty.

III.

From the age of Galen, or perhaps from that of Herophilus and Erasistratus, down to the present time, the hypothesis has been maintained with little variation, that the brain presides over the body through the spinal marrow and the nerves. A fluid was supposed to be secreted from the brain, and transmitted through the nerves, which were supposed to be tubes; this fluid was universally distributed to the moving and sensible parts of the frame, and through the agency of this fluid all the phenomena of life were presumed to be carried on. This notion is easily conceived, and corresponds with the language of the learned and unlearned. But it is utterly at variance with anatomy; for if the brain is the common source of this fluid, where is the necessity for the double and triple set of nerves given to one organ, and what is the explanation of the intricate connexions formed amongst the nerves? If this supposed nervous fluid were equal to all the phenomena exhibited in the nervous system, if there were one kind of influence prevailing, we should have expected to find the nerves diverging regularly from the brain to all parts of the body. But this is by no means the case.

IV.

A critic, with no unfriendly intent, has attempted to show that my opinions are nothing more than those of Galen. I should have been proud to be able to say, that I had reconciled the theories of the ancients with the more perfect knowledge of modern anatomists; but I fear it is not so. The division of nerves arising from the brain into those of sensation and motion, or into hard and soft nerves, proposed by Galen, implies no more than that he understood that there were nerves appropriated to the organs of the senses, and nerves for the governance of the muscles. Neither does the idea of Galen, that the ganglion was given to a nerve when strong motory powers were required, savour much of the distinction now discovered. Galen supposed motion and sensation to be the properties of the same nerve, but considered motion to be active and sensation passive, and it was possible, he thought, that there might be nervous power sufficient for sensation, though not for motion. Thus he explained how it happened that sensation remained when motion was lost. And the same idea has been entertained by some more modern authorities.

Vesalius resisted the authority of Galen on many points, but he adopted with little variation both his description of the anatomy of the brain and nerves, and his opinions on the nervous system. According to him the vital spirits were elaborated in the brain, and transmitted from the ventricles of the brain into the spinal marrow and the roots of the nerves, and so sent over the body. Willis indeed gave an arrangement of the system, adapted to the appearance presented on dissection, and he entertained many ingenious conjectures on the uses of the parts of the brain; but still that organ was with him the sole *officina spirituum*, the source of that subtle spirit which was distilled through the nerves. And if Willis be found engaged in an inquiry whether there be a vital and animal spirit, or a sensorial and motor spirit, it is hypothetically, and neither founded strictly on anatomy nor on experiment. All these questions are touched on by Haller, where in the end he concludes—But I know not a nerve which has sensation without also producing motion; the nerve which gives feeling to the finger is that which moves the muscles; and the fifth nerve of the brain branches to the papillæ of the tongue, and also to the muscles. It is therefore certain that Haller, who had traced the opinions of authors with the utmost diligence, gathered nothing from the ancients. The confusion in his mind, as well as in the minds of our most learned physicians and commentators, declared the necessity of having recourse to the volume of nature itself.

V.

Dr. Baillie left his account of the nervous system to be published after his death. In that publication we have a perspicuous detail of the system which I have alluded to: and these were the doctrines he taught with universal approbation in the school of Windmill-street. Mr. Wilson, my immediate predecessor and colleague, in the same school, did not deviate from that system in the slightest particular. Such then was the system followed universally, and taught by my colleague, and in my own school.

If men look upon the same object in one unvarying aspect, they will probably receive a similar impression, and describe what they see in nearly the same words. The error throughout has been in tracing the nerves from the brain, and taking the instance of the human body, that is, the highest and most complicated form as the foundation of the system, instead of tracing the nerves through the changes they exhibit in different animals, in correspondence with the formation of these animals, or the organs they possess.

When it was discovered that the lower creatures move and shrink from injury, and yet possess no nerves, it was not to be supposed that such creatures had no nervous matter in their composition. Such a supposition would have drawn us into the difficulty of being forced to admit that the ways of nature were not uniform—that sensation and motion were in one creature endowments of the nervous system, whilst in another a different mode of action was in operation. This consideration forces on us the belief that the nerves which appear in creatures that have distinct organs, or muscles that require to be combined in operation, are introduced to combine parts which singly, and as insulated parts, are already (in these lower animals) in possession of vital power. That power is no doubt possessed through the operation of the same diffused nervous matter in all animals, from the simplest up to man.

VI.

When this is understood, a material difficulty in our investigation is removed; we obtain a clew to the increasing complication of nerves seen in animals as we ascend in the scale of existence. The lowest condition of the nervous system is in animals which are not symmetrical in form, and which have imperfect organs of motion. In such animals an irregular central ganglion, with an attached nerve, is all which is perceived. But if a creature possess regular organs of progression, and consequently an arrangement of many muscles to produce a combined operation, we shall find an orderly provision of nerves. The foot of the gastropoda is known to have little rough points, which lay hold on a surface; each of these points has its regular muscle, and each muscle has its nerve; so that a central chain or a cauda equina of diverging filaments may be seen.

But if such an insect as the *scarabæus nasicornis*, for example, be dissected before and after its metamorphosis, a singular change in the nervous system will be observed to correspond with the change in its organs of motion. The chain of ganglia and diverging nerves, which were appropriated to the numerous muscles of its *foot*, disappear, and the system appropriate to the winged insect takes their place.

VII.

What we see accompanying the change of structure in the same insect, examined before and after it takes wing, may be seen more satisfactorily by comparing one animal with another which differs in organization; for example, as new organs of sense are bestowed in the ascending scale of animals, new nerves and new ganglions are given; and as new or more perfect organs of motion are bestowed, we still perceive the increasing number and magnitude of the nervous cords.

VIII.

The idea so naturally inculcated by this manner of surveying the nervous system, in its gradual development from the less perfect to the more complicated animal, has been perverted by the influence of the celebrated Bichat. His influence has been very extensive on the continent, and his belief was, that the chain of ganglionic nerves, seen in the worm or the leech, was the same with that which is called the sympathetic system in man and the higher order of animals.

We must speak of Bichat with the respect which is due to a man of genius; he possessed ingenuity, industry, and eloquence. It was this eloquence, united to an indifference for the authorities in anatomy, and the extraordinary condition of Europe at the time of his publication, that overpowered the physiologists of the continent, and by which misconceptions were entertained as to the relative importance of the parts of the nervous system. Nothing it appears would suit the time (the commencement of the French revolution) but the entire overthrow of former systems, and the substitution of a new theory. It was the pleasure of Bichat to divide the nerves into two distinct systems, instead of the one uniform system of the ancients, in which the nerves were supposed to proceed from the sensorium, as a grand centre, and from that to derive their powers. One of his nervous systems he conceived to have its centre in the brain, consisting of the nerves destined to receive impressions, and of the nerves which convey the influence of the will to the muscular system. The other had many centres. The power of this last system emanated from the ganglions, which he observed largely scattered among the viscera; and each ganglion he conceived, with the authorities above, though he was far from acknowledging such authorities, to be a distinct source of nervous influence, whilst a relation was preserved between them by connecting nerves. The first was, according to this author, the nervous system of the animal life, having one centre in the brain, to which sensation is propagated, and from which motion proceeds; whilst the second system was for organic life, had many distinct centres, and many functions relating to the operations of the animal economy, over which the mind had no power.

This bold invention was supported by many curious instances, and its author exhibited much knowledge, as well as ingenuity: but it was anatomically incorrect, and nothing more clearly evinced the wrong methods of study prevailing on the continent, than the acquiescence and approbation with which this system was received there. Two errors pervaded the whole, which ought not, for an instant, to have been left undetected. The first was in screening from himself what he could not be ignorant of—that the cerebral nerves also have ganglions; that thirty-one pairs of large ganglions, in regular order, and carefully protected, like important organs, are to be found in the nerves of the head and spine. This at once should have caused the rejection of the name of ganglionic system of nerves, given to his nerves of organic life. But his error was not merely the misapplication of a name: there was misconception and radical error throughout the whole system. Although Bichat's *ganglionic system* was presented with the aspect of novelty, there was, in truth, no actual discovery. Anatomists had already convinced themselves that the sixth nerve was not the root of this sympathetic nerve; that a filament so small could not be the trunk of that system which, expanding into larger branches, and furnished with numerous ganglions, was seen to pervade the whole viscera, and to connect itself with every nerve of the body. The opinion had been propagated that it was a system of visceral nerves extending every where, and not depending upon the encephalon.

But the most remarkable misconception of Bichat was, in imagining that he saw, in the ganglionic system, or the sympathetic system of man, the development of that series of nerves which is seen in the lower creatures: thus considering those nerves which, in them, give sensation and volition, to be the same system which, in the human body, even by his own showing, give no token of being either the organ of sensation or of voluntary motion.

IX.

Since we have touched upon this subject, I may here state what is known of the *sympathetic nerves*. When I began study, it was usual to demonstrate this nerve as a nerve of the brain, descending more directly from the sixth and the second division of the fifth nerves—to trace it through the carotid foramen, down the neck with the *nervus vagus,* and so on to its divisions to the heart, and then as *intercostal* to the viscera. This term, intercostal, sufficiently marked its connexions; it was so called from the frequency of its connexions with the intercostal nerves, viz. the spinal nerves which take their course between the ribs.

X.

It being acknowledged that nerves were the only bonds by which the sympathies of distant parts were to be accounted for, and physicians observing the connexions between the different parts, the emotion expressed in the face, the affection of the organs of sense, that blushing proceeds from the influence of passion on the body, and even such connexions as sneezing from tickling the nose: all these were accounted for by sympathy through this nerve; and hence, for distinction, it was called the sympathetic nerve. The experiments detailed in this volume will clear away that mass of error in which physiologists were involved. But I am now the more bound to state our obligations to Bichat, having shown how far, in some respects, he was incorrect. To him we owe the important fact, that there is no sensibility in the branches of the sympathetic nerve, nor in the ganglions formed in its progress. These parts may be cut and pinched in the living body without producing pain, and they move no muscular apparatus, as far as we at present perceive.

XI.

The functions of this system are known only by negatives: we have ascertained that they have nothing to do with volition, nor with sensation, nor with respiration, nor with expression, nor with sound and speech.

We are left therefore to the conjecture, that the sympathetic nerve, or the ganglionic system of nerves, according to Bichat, are for those thousand secret operations of a living body which may be called constitutional. Circulation, secretion, and absorption, are operations which simultaneously affect the entire frame. Constitutional peculiarities, fever, and general derangement of health, must, we conceive, belong to this system of nerves.

And we call it system; for it is curious to observe, that by the progress of anatomy this lesson has become easy. Painfully, and with a stretch of memory, we were formerly endeavouring to recollect the relations and connexions of the sympathetic nerve, but now we know that it is extended universally; that its relations to the nerves of the head are not more remarkable (when looked upon free of hypothesis) than its branches to the nerves of the extremities; that it extends to all the internal viscera. It is universally distributed to all parts of the body; and in this is its peculiarity.

XII.

As to the origin of the sympathetic nerve, we cannot assign it a commencement. It has a twig from each nerve of the spinal marrow; but these are very small nerves, compared with the mass of nervous matter seen in the centre of the viscera of the abdomen.

The semilunar ganglion and the solar plexus being parts of this system, and the branches of nerves extending and diminishing from this region, give countenance to the idea that we have here the centre of the sympathetic system.

This conjecture is countenanced by the fact, that these viscera of the abdomen perform functions the most independent of the will, and over which the mind has no control. Indeed, it appears to be one of the happiest provisions that these functions of vital importance are withdrawn from the governance of the mind. No part of the human body is altogether independent. When, by circuitous influence, the mind does operate on the vital functions, we know what disturbance is produced; which is enough to show with what beneficial effects the relations are made remote.

Here the investigations of Dr. Wilson Philip become of great interest, as distinguishing between the sensorial powers, the functions of nerves in connexion with the sensorium, and those vital operations belonging to constitutional functions. But even these, highly as we must prize them, must be revised under a more accurate knowledge of the different nerves and distinct ganglions, than prevailed at the commencement of his inquiries.

SECOND PART.

BEING

A FURTHER EXPOSITION OF THE SYSTEM OF THE NERVES.

A desire having been expressed to see a simple and connected view of the system of the nerves, the following account was drawn up for this purpose*. Something of this kind had become necessary in addition to the papers published in the Philosophical Transactions: for although those dissertations explain some of the remarkable facts brought out in the course of the investigation, they do not convey an idea of the system as I have conceived it; nor display its chief excellence, which is its simplicity, and the order which has been introduced into the demonstration of the nerves.

My conceptions of this matter arose by inference from the anatomical structure; so that the few experiments which have been made were directed only to the verification of the fundamental principles on which the system is established.

In France, where it has been attempted to deprive me of the originality of these discoveries, experiments without number and without mercy have been made on living animals; not under the direction of anatomical knowledge, nor by what I should consider to be the right method of induction, but prosecuted with cruelty and indifference, in hope to catch at some of the accidental facts of a system which, it is evident, the experimenters did not fully comprehend.

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* Written as introductory to the first edition.

The view which I have taken of the nerves has not been the result of hasty and premature conjecture, but of patient investigation. From the first year of my delivering lectures, my demonstrations of the brain were given in a manner not then common; and to this peculiarity in the manner in which I looked on the connexions of the brain, I trace the origin of opinions different from those hitherto entertained. By the time I began to lecture in Windmill-street, I was enabled to follow, in my demonstrations of the nerves, an arrangement which has given a new interest to the subject, and which, by imperceptible degrees and improvements from year to year, during every succeeding course of demonstration, has at length developed the comprehensive system which I have now to present to the reader.

The steps by which I have cautiously advanced have been observed only by my older and more diligent pupils; who, becoming interested in the subject, have returned, during successive years, when it was under consideration, to hear how I continued to prosecute it. They have seen the system gradually developed, and have heard me announcing the desiderata as the inquiry proceeded, and explaining the difficulties;

and they have seen how the points which were in one season the most obscure have, by diligent investigation, become those of the very highest interest in succeeding courses.

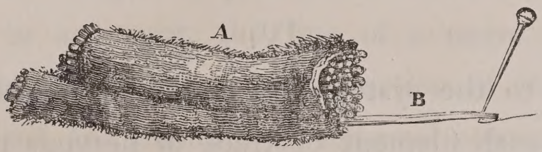
In the view which I have taken of the nerves of the human body, there are, besides the nerves of vision, smell, and hearing, four systems combined into a whole. Nerves entirely different in function extend through the frame; first, those of sensation; secondly, those of voluntary motion; thirdly, those of respiratory motion; and lastly, nerves constituting the sympathetic system, which from their being deficient in the qualities that distinguish the three others, seem to unite the body into a whole, in the performance of the functions of nutrition, growth, and decay, and whatever is directly necessary to animal existence. Of these, the two first are bound together through their whole course; the third are partially joined to the two former; and the last are the most irregular of all.

I.

A nerve, as we see it taking its course in the human body, is a dense white cord: the density is entirely owing to the membranous coverings of the nerve. There are three which correspond with the coverings of the brain, and indeed which may be traced from them. What corresponds with the *pia mater* is a delicate and vascular membrane, which forms minute sheaths or tubes, in which the proper matter of the nerve is contained.

II.

These nerves are sometimes separate; sometimes bound together; but they do not, in any case, interfere with or partake of each other's influence *.



If we take up a nerve to examine it, we find that it consists of distinct filaments; but there is nothing in these filaments to distinguish them from each other, or to declare their offices. One filament may be for the purpose of sensation; another for muscular motion; a third for combining the muscles in the act of respiration. But the subserviency of any of all these filaments to its proper office must be discovered by following it out, and observing its relations, and especially its origin in the brain and spinal marrow. In their substance there is nothing particular. They all seem equally to contain a soft pulpy matter enveloped in cellular membrane or pia mater, and so surrounded with a tube of this membrane as to present a continuous track of pulpy nervous matter, from the nearest extremity in the brain to the extremity which ends in a muscle or in the skin.

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* A. represents a nerve with its sheath or neurilema; B. a single filament dissected out.

III.

Previous to the observations which I have made, such a nerve as I have described was supposed to have all its threads alike; they were supposed to be branches from the same root, and all capable of exciting a muscle or conveying a sensation.

IV.

The key to the system will be found in the simple proposition, that each filament or track of nervous matter has its peculiar endowment, independently of the others which are bound up along with it; and that it continues to have the same endowment throughout its whole length. If we select a filament of a nerve, (for example, one of those in the compound nerve represented above), and if its office be to convey sensation, that power shall belong to it in all its course wherever it can be traced: and wherever, in the whole course of that filament, whether it be in the foot, leg, thigh, spine, or brain, it may be bruised, or pricked, or injured in any way, sensation and not motion will result; and the perception arising from the impression will be referred to that part of the skin where the remote extremity of the filament is distributed.

V.

As the matter of the nerve is every where the same, and the apparent difference is only in the manner in which the fine cellular membrane forms the envelope, (it being soft where the nerve is protected, hard and cordlike where it is exposed or subject to pressure;) I have been desirous of having some term or terms which might be applicable to the same tract of matter through its different stages, whether traced in one direction or the other.

Where certain whitish streaks of nervous matter are discoverable in the substance of the brain, we may still use the term *Tractus* as being already an anatomical term.

Where, in any part, the line of a nerve is not merely discoverable by its colour, or the direction of its texture, but when it is raised, and exhibits an external convexity in form of a cord, the term *Column* or *Rod* may be used.

Where they emerge in distinct threads, *Funiculi* has seemed to me a proper term; and where these *funiculi* are projected in combination, I use the word *Fascis*. Although we must keep the term *Nerve*, yet it is, as we may say, an abused term. Let us only distinguish betwixt a simple and a compound nerve.

VI.

A simple nerve is where the threads or funiculi which form its root arise in a line or sequence from the brain or spinal marrow. A compound nerve is where the threads forming the roots arise in double rows, and each row from a different column or tract of nervous matter; for example, the Ninth Nerve (ix. plate 4) is simple; a Spinal Nerve (plate 3) is compound.

VII.

A Nerve, then, is a cord composed of nervous matter and cellular substance; the nervous matter is in distinct funiculi, and these funiculi are bound together in their course to the point of distribution, although they may possess properties quite dissimilar.

If we were successfully to trace a nervous cord, (we shall suppose from a muscle of the fore-arm), it would be found a simple filament, thread, or funiculus. We should first trace it into a compound nerve; perhaps the ulnar nerve; which we call compound, because there are in it filaments of motion and filaments of sensation bound together. At the root of the axillary nerve we should trace it into the composition of a *fascis*, where it forms the anterior root of a spinal nerve (as C, plate 3). Being further traced, it would merge in the anterior column of the spinal marrow; and traced into the base of the brain, it might be followed as a *tractus*, a streak of matter distinguishable from the surrounding substance, until it was seen to disperse and lose itself in the cineritious matter of the cerebrum. In all this extent, however combined or bound up, it constitutes one organ, and ministers to one function, the direction of the activity of a muscle of the hand or finger.

And so if we trace other funiculi or filaments, whether they be for the purpose of sensation or of motion, each retains its office from one extremity to the other; nor is there any communication between them, or any interchange of powers, further than that a minute filament may be found combined with filaments of a different kind, affording a new property, not to the nerve thus constituted, but to the part which receives them in their final distribution.

VIII.

Wherever we trace nerves of motion we find that, before entering the muscles, they interchange branches, and form an intricate mass of nerves, or what is termed a *plexus*. The plexus is intricate in proportion to the number of the muscles to be supplied, and the variety of combinations into which the muscles enter. The filaments of nerves which go to the skin regularly diverge to their destination. The nerves on the face, and those on the side of the neck, form plexus; but the grand plexus are near the origins of the nerves of the upper and lower extremity. And from the fin of a fish to the arm of a man the plexus increases in complexity in proportion to the variety or extent of motions to be performed in the extremity.

Muscles are arranged and combined together, not by any connexion between themselves, but between the nerves going to them; a *plexus* is that network formed by the interchange of the filaments of nerves before they penetrate to the muscles. It is through the connexions formed in the plexus that some muscles are combined into a class, so that they act, as it were, by one impulse; and it is by the same means that others are arranged as their opponents. All the varieties of combinations are formed in the plexus, and there the curious relations are established which exist between the contraction of one class and the relaxation of the other.

THIRD PART.

OF THE SPINAL MARROW.

I.

Taking the spinal marrow as a whole, its offices are of a double order. First, in relation to the brain. Secondly, as having powers emanating from itself, or independent of the brain.

II.

Through the spinal marrow columns extend from the grand subdivisions of the brain, which are intermediate between the sensorium, the nerves of the body, and the extremities. It is for this reason that we look with so much interest on those columns which give origin to the two roots of the spinal nerves, since they propagate influences directly in connexion with the operations of the mind: such as sensation and volition.

III.

It is not determined whether the ceneritious matter visible in the section of the spinal marrow belongs to the columns which have reference to the brain, or are distinct organs and new sources of power.

IV.

The spinal marrow is peculiar to the vertebral animals. It will suffice for superficial observers to say, that it must be so, because the spine is necessary to conceal and protect the marrow: but there is much more than this in the established relationship; the spine formed by vertebræ is necessary to such a constitution of the thorax as shall be capable of the motion of respiration; and the spinal marrow is equally necessary to that form and distribution of the nervous system which is required for associating and combining the muscles of respiration. Without the machinery of the spine and ribs, the thorax and abdomen could not rise and fall in respiration; and without the spinal marrow, that arrangement of nerves would be wanting which is necessary to regulate the motions of the trunk in respiration. Thus the spinal marrow, the spine and ribs, and the muscles of respiration, are essential to each other; as constituting the several parts of a grand design subservient to respiration.

V.

Each lateral portion of the spinal marrow contains three tracts or columns; one for voluntary motion, one for sensation, and one for the act of respiration: this is quite obvious at the upper part or medulla oblongata; with respect to the lower part of the spinal marrow, the reasoning is more hypothetical or analogical. There the motor roots and the sensitive roots arise in the same manner as at the upper part: and as the common nerves of the spinal marrow certainly possess a power over the abdominal muscles, controlling them in the act of respiration, it is not an unwarrantable supposition, that the respiratory column descends along the spinal marrow, constituting a part of it, and bestowing power upon the spinal nerves. So that the spinal marrow comprehends in all six rods, intimately bound together, but distinct in office; and the capital of this compound column is the *medulla oblongata.*

These six columns of the spinal marrow are discoverable on looking to the upper part of that body; but no doubt these grander columns contain within them subdivisions. Thus, if we lift up the medulla spinalis from the cerebellum, and look to it on the back part, we shall see more numerous cords, the offices of which will one day be discovered.

VI.

This view of the constitution of the spinal marrow led me to institute experiments, which were followed by the discovery of the distinct functions performed by the several roots of the spinal nerves; but without stating these experiments or their results, we shall proceed with the general view.

VII.

The anterior column of each lateral division of the spinal marrow is for motion; the posterior column is for sensation; and the middle one is for respiration. The two former extend up into the brain, and are dispersed or lost in it; for their functions stand related to the sensorium: but the latter stops short in the medulla oblongata, being in function independent of reason, and capable of its office independently of the brain, or when separated from it.

VIII.

It is the introduction of the middle column of the three, viz. that for respiration, which constitutes the spinal marrow, as distinct from the long central nerve of the animals without vertebræ, and which is attended with the necessity for that form of the trunk which admits of the respiratory motions.

IX.

In animals which do not breathe by an uniform and general motion of their bodies, there is no spinal marrow, but only a long compound and ganglionic nerve, extending through the body for the purpose of sensation and motion. This cord in those creatures does not actuate the animal machine with alternate dilatation and contraction. There may be a motion of some part which admits and expels air from a cavity, or agitates the water, and which motion is subservient to oxygenation of the blood; and there may be a nerve supplied to that apparatus with sensibility and power suited to the function thus to be performed, and resembling our par vagum in office; but there is no regular and corresponding distribution of a respiratory system of nerves to both sides of the body, nor any arrangement of bones and muscles, for a general and regular motion of the frame like that which takes place in vertebral animals, and which is necessary to their mode of existence.

X.

An injury to the brain, sufficient to destroy sensation and volition, leaves the spinal marrow in possession of its function, and commanding the actions of respiration.

XI.

The experiments of Le Gallois, in which he cut down the brain to the medulla oblongata, exhibit the respiration continued when the brain is removed. The observations of Mr. Lawrence and others shew that the acephalous child lives and breathes* without a brain, if the medulla oblongata be formed and perfect.

XII.

Injury to the spinal marrow low in the neck, cutting off the sensation and voluntary motions of the body, leaves the body in possession of the power of respiration.

XIII.

These facts exhibit the importance of the spinal marrow to the act of breathing, and point to the upper part of the column, the medulla oblongata, as particularly the seat of this power. But a difficult question remains. The act of respiration in man, and in general in the higher animals, is not subservient to the circulation of the blood, and to the general economy merely. The machinery of respiration becomes a grand power, under the command of the will, and efficient in crying, speaking, smelling, &c. It will be difficult to determine how the power of respiration, residing in the spinal marrow, and independent of the brain in its primary and most important office, is brought to be subservient to the will. Is it by a prolongation of the appropriate column of the spinal marrow up into the brain, or is it by the junction of cerebral and voluntary nerves with the respiratory nerves of the medulla oblongata?

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* See Appendix.

XIV.

From this digression we return to the spinal marrow, to inquire what are its comparative functions. In animals having a simple line of nerves with ganglions, as in the earth-worm, the anterior ganglions, although the smaller ones, have a control over the rest of the body. If such a creature be divided, the anterior part will preserve its concatenated motion, and move away; the posterior half will remain writhing, as if suffering, but its motions want aim, and it remains in the same spot. Cold-blooded animals will live without the brain. Birds whose heads were cut off, Le Gallois says, walked, seemed to feel pain, and moved their feet towards the part. Flourens goes further, since he says that a bird deprived of the cerebral lobes dressed its feathers, and ran and leaped.

Although I trust very little to these observations, it must be conceded that in the lower creatures the brain does not possess all that influence, either on the movements of the frame or on the life itself, that it does in man, and in the higher animals;

and that it becomes more and more important in proportion as the animals rise in the scale of intelligence.

The question must therefore be asked, how far does the spinal marrow retain the offices of the ganglionic system of the vermes for example? how far is it independent of the brain? and what is the mode and the degree of relation between the brain and spinal marrow? Such appears to me to be the course of study which is to improve the knowledge of the nervous system. Experimenters have gone much too far, into subjects of extreme delicacy, and to the discussion of which their knowledge is not competent, until these leading questions be satisfactorily answered. This conviction has at least influenced me in restricting me to the functions of the nerves, in distinction to speculations on the influence of the brain.

FOURTH PART.

OF THE NERVES WHICH ARISE FROM THE SPINAL MARROW. —COMPARISON WITH THE NERVES OF THE ENCEPHALON.

I.

The first conception which I entertained of the true arrangement of the nerves arose from a comparison of the nerves which take their origin from the brain with those which arise from the spinal marrow. The perfect regularity of the latter, contrasted with the very great irregularity of the former, naturally led to an inquiry into the cause of this difference. I said, if the endowment of a nerve depend on the relation of its roots to the columns of the spinal marrow and base of the brain, then must the observation of their roots indicate to us their true distinctions and their different uses.

II.

The spinal nerves are perfectly regular in origin and distribution, and are thirty on each side*. Each nerve has two distinct series of roots coming out in packets or fasces, one from the posterior column, and one from the anterior column, of the spinal marrow.

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* The tenth nerve of the head, as enumerated by Willis, and called suboccipital from its situation, is in constitution a spinal nerve; *i. e.* it has a double root and a ganglion on its posterior root. Its distribution is similar to the spinal nerves, and quite unlike those of the encephalon, with the exception of the fifth.

III.

The posterior fascis is formed of funiculi, (see plates 3 and 8, fig. 2) which come out with remarkable abruptness from the column; and their roots form a very regular row or series along the sides of the spinal marrow. They seem at once to burst out from the confinement of the arachnoid coat. These funiculi, converging towards the foramen of the sheath of the spinal marrow, and being collected together, form a ganglion. This ganglion is not seen within the sheath of the spinal marrow; its seat is in the part where the fascis is surrounded and united to the sheath, and just before this root of the nerve joins the anterior one to constitute a spinal nerve.

IV.

The funiculi of the anterior roots of these nerves gather their minute origins with more irregularity than the posterior; and from a wider surface.

V.

The thirty nerves thus formed of two distinct fasciculi, are suited to perform all the common offices of the trunk and limbs. Is it, then, by that combination of properties which they acquire through their double roots, that they are capable of performing their offices? And is this the cause of their simplicity of arrangement in their course through the body, as contrasted with the nerves of the head? Again, what cerebral nerves, in their distribution to the head and face, correspond in office with the spinal nerves? On the solution of these questions will depend our knowledge of the whole nervous system.

VI.

It was necessary to know in the first place, whether the phenomena exhibited on injuring the separate roots of the spinal nerves corresponded with what was suggested by their anatomy. After delaying long on account of the unpleasant nature of the operation, I opened the spinal canal of a rabbit, and cut the posterior roots of the nerves of the lower extremity; the creature still crawled, but I was deterred from repeating the experiment by the protracted cruelty of the dissection. I reflected, that an experiment would be satisfactory, if done on an animal recently knocked down and insensible; that whilst I experimented on a living animal, there might be a trembling or action excited in the muscles by touching a sensitive nerve, which motion it would be difficult to distinguish from that produced more immediately through the influence of the motor nerves. A rabbit was struck behind the ear, so as to deprive it of sensibility by the concussion, and I then exposed the spinal marrow. On irritating the posterior roots of the nerve, I could perceive no motion consequent in any part of the muscular frame; but on irritating the anterior roots of the nerve, at each touch of the forceps there was a corresponding motion of the muscles to which the nerve was distributed. Every touch of the probe, or needle, on the threads of this root, was attended with a muscular motion as distinct as the motion produced by touching the keys of a harpsichord. These experiments satisfied me that the different roots and different columns from whence those roots arose were devoted to distinct offices, and that the notions drawn from the anatomy were correct.

VII.

The anterior roots of the spinal nerves, and the anterior column of the spinal marrow, being thus shown to have a power over the muscular system, the next step of the inquiry was distinctly indicated. If I pursue the track of the anterior column of the spinal marrow up into the brain, shall I find the nerves which arise from it to be muscular nerves? An anatomist will at once answer, that only muscular nerves arise in this line.

Pursuing this method we see the anterior root of the spinal nerve, arising from this column. We trace the column up into the corpus pyramidale, and find there the origin of the ninth nerve. We see that this nerve has only one series of roots, corresponding with the anterior roots of the spinal nerves, and that these roots come from the *tractus motorius*, and we cannot forget that this nerve is entirely devoted to the muscles of the tongue; that it is the motor of the tongue, and has nothing to do with the sensibility of that organ.

Following up the corpus pyramidale, we find issuing from it the sixth nerve, a muscular nerve of the eye. Still following up the *tractus motorius* through the *pons Varolii*, we come to the roots of the third nerve, the motor nerve of the eye. *Thus all the nerves arising in this line from the Crus Cerebri to the Cauda Equina are muscular nerves.*

VIII.

On finding this confirmation of the opinion, that the anterior column of the spinal marrow and the anterior roots of the spinal nerves were for motion, the conclusion presented itself that the posterior column and posterior roots were for sensibility. But here a difficulty arose. An opinion prevailed that ganglions were intended to cut off sensation; and every one of these nerves, which I supposed were the instruments of sensation, have ganglions on their roots.

Some very decided experiment was necessary to overturn this dogma. I selected two nerves of the encephalon; the fifth, which had a ganglion, and the seventh, which had no ganglion. On cutting across the nerve of the fifth pair on the face of an ass, it was found that the sensibility of the parts to which it was distributed was entirely destroyed. On cutting across the nerve of the seventh pair on the side of the face of an ass, the sensibility was not in the slightest degree diminished.

By pursuing the inquiry, it was found that a ganglionic nerve is the sole organ of sensation in the head and face: ganglions were therefore no hinderance to sensation; and thus my opinion was confirmed, that the ganglionic roots of the spinal nerves were the fasces or funiculi for sensation.

It now became obvious why the third, sixth, and ninth nerves of the encephalon were single nerves in their roots, as contrasted with the spinal nerves; for if the fifth nerve bestowed sensibility universally on the head and face and all the parts contained, there was no necessity, so to speak, for the third, sixth, and ninth, having the posterior or ganglionic root.

IX.

Pursuing the subject, and still directed by the anatomy, the next matter of inquiry was to ascertain how far the fifth nerve of the encephalon corresponded with the spinal nerves. It was discovered that the fifth nerve bestowed sensibility on all the cavities and surfaces of the head and face. It was also observed, that where the sensibility of the integuments remained after the division of the fifth nerve, it was only to the extent of surface supplied by the nerves of the spine. Where certain fibrils of the spinal nerve extended upon the integuments of the side of the jaw, they were equivalent in office to those of the fifth nerve. In short, in regard to their property of bestowing sensibility, the fifth and the spinal nerves were identified.

But was the fifth nerve in other essential circumstances similar to the spinal nerves? On recurring to the anatomy, and comparing the fifth nerve of the encephalon with a spinal nerve, the resemblance, both in man and brutes, was very remarkable. In plate VII, fig. 1 and 2, we recognise corresponding parts in the spinal nerve and in the fifth nerve. In both nerves we see the double roots; the anterior root passing the ganglion, and the posterior root falling into it or forming it*. On following back the anterior root of the fifth nerve, we may perceive that it comes out between the *funes* of the pons varolii, and, apparently, from the crus of the cerebrum.

Observing that there was a portion of the fifth nerve, which did not enter the ganglion of that nerve, and being assured of this fact by the concurring testimony of anatomists, I conceived that the fifth nerve was in fact the uppermost nerve of the spine; or to speak more correctly, the most anterior of the double nerves common to man and animals, of those nerves which order the voluntary motions, and which at the same time bestow sensibility, in its extended sense, on the frame of the body.

This opinion was confirmed by experiment. The nerve of the fifth pair was exposed at its root, in an ass, the moment the animal was killed; and on irritating the nerve, the muscles of the jaw acted, and the jaw closed with a snap. On dividing the root of the nerve in a living animal, the jaw fell relaxed. Thus its functions are no longer matter of doubt: it is at once a muscular nerve and a nerve of sensibility. And thus the opinion is confirmed, that the fifth nerve is to the head, what the spinal nerves are to the other parts of the body, in respect to sensation and volition.

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* It is curious to notice the uses which were ascribed to this grand ganglion. Vieussens supposed that it strengthened the nerve; others that it was the bond of sympathy and the source of expression in the countenance: "Et affectuum animi indicia in faciei partibus depingere adjuvet."—*Hirsch.* Sandifort Thes. Dissert. p. 491.

X.

But here a very important circumstance must be noticed. The origin of the fifth nerve being distant from the termination of the column of the spinal marrow for respiration, it receives no roots from it. How then are the features to be moved in sympathy with the lungs, and with the respiratory actions of the breast, neck, and throat? We shall find presently that this is effected through the portio dura of the seventh, and that this is the reason of the very distinct origin and different course of the two nerves.

I have now only to add, that these facts and experiments have been followed up by others to the satisfaction of all Europe. The opinion has been confirmed that the anterior roots of the spinal nerves bestow the power of muscular motion; and the posterior roots sensibility. When the anterior roots of the nerves of the leg are cut in experiment, the animal loses all power over the leg, although the limb still continues sensible. But if, on the other hand, the posterior roots be cut, the power of motion continues, although the sensibility is destroyed. When the posterior column of the spinal marrow is irritated, the animal evinces sensibility to pain; but no apparent effect is produced when the anterior column is touched.

OF THE SYMMETRICAL SYSTEM OF NERVES.

EXPLANATION OF THE PLAN, PLATE I.

I SHALL now proceed, by reference to the adjoined plate 1, to explain the symmetrical system of nerves. We see thirty-one nerves similar in origin and constitution, ranging with perfect order, and going forth to the head, body, and limbs in regular succession; and in their essential attributes, common to every class of animals, from the creeping thing* up to man.

When we contemplate the dissection which we have made of the nerves of the face, neck, and chest, and are lost in the confusion of the IIId, IVth, Vth, VIth, VIIth, VIIIth, and IXth of the branches of the Cervical Nerves, and of the Sympathetic—of the Diaphragmatic, Spinal Accessory, and Inferior External Respiratory Nerves—we shall be prepared to see the advantages of the plans which are annexed. The reader will soon discover that the system, of which these plans may give him some idea, is not only an improvement in the knowledge of the structure and functions of animal bodies, but is of the greatest use in practical anatomy, in facilitating the acquisition of the knowledge of the Nerves.

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* This will be condemned as a term not systematic, but it is strictly correct. It is the necessity of a correspondence in the motions of the body and feet which, if we may so express it, calls for symmetry in the distribution of the nervous system. When a creature has no feet, or substitute for them, there is no symmetrical system of nerves. If we were to consider the necessity of correspondence in the motions of the hands and feet, as well as in the four quarters of brutes, that each foot does not move by itself, but, on the contrary, that there is a combination of motion betwixt the limbs in walking, ambling, trotting, galloping, &c., we should see that the muscular system must be united by a longitudinal cord and uniformity of branches going out laterally.

The arrangement is this:—There is an obvious division of the medulla spinalis into anterior and posterior columns: every regular nerve has two roots, one from the anterior of these columns, the other from the posterior: and they have all ganglions of a particular structure upon the posterior root. Such are the Vth pair; the Suboccipital; the seven Cervical; the twelve Dorsal; the five Lumbar; and the five Sacral; viz., thirty-one pairs of perfect, regular, or double nerves in the human body*. These are laid down in the first plan. They are common to all animals, from the worm up to man; and are for the purposes of common sensation and motion, or acts of volition; they run out laterally to the regular divisions of the body, and never take a course longitudinal to the body.

For the sake of distinction and arrangement, the remaining nerves are called IRREGULAR NERVES. These are distinguished by having only a single fasciculus, or single root; that is, a root from one column. They are *simple* in their origin; *irregular* in their distribution; and deficient in that symmetry which characterizes the first class. They are superadded to the original class, and correspond to the number and complication of the superadded organs. Of these there are—the IIId, IVth, and VIth to the eye; the VIIth to the face; the IXth to the tongue; the *Glosso-Pharyngeal* to the tongue and pharynx; the *Nervus Vagus* to the larynx, heart, lungs, and stomach; the *Spinal Accessory* to the muscles of the shoulder; the *Phrenic* to the diaphragm; the *External Respiratory* to the outside of the chest. These (with the exception of the two last which are undistinguishable at their roots) have single roots, that is, funiculi coming from one column; and are thus distinguishable from the fifth nerve of the head, and the thirty nerves of the spine.

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* There can be no doubt of the accurate resemblance of the fifth to these other thirty nerves; although it may be difficult to trace the roots of the nerve to the prolonged columns from which the spinal nerves come. This is a subject which I mean to prosecute. The last author on this subject is very distinct in tracing the sensitive root of the fifth to the column from which the posterior roots of the spinal nerves arise; and the motor root he represents coming from between the fibres of the pons varolii, as if it arose from the tract leading to the crus cerebri. See Icones Atnaomicæ Neurologicæ, Fasc. i. Tab. xxviii. xxxi. Langenbeck. Gottingæ.

If we inquire into the seeming confusion in this second class, or class of *irregular nerves,* we shall perceive that it is owing principally to the complication of the superadded apparatus of respiration, and to the variety of offices which this apparatus has to perform in the higher animals.

We may even now observe that, in the apparently regular system of Willis, there was in fact great confusion. Since the nerves, the most opposite in use, were arranged together; and, indeed, whilst such a system remained undisturbed, our knowledge of the nerves could not be advanced.

A A
B B } Spinal Marrow.
C C

1 1 Branches of the Vth pair, or Trigeminus, which arise from the union of the crura cerebri and crura cerebelli in two distinct roots, on the posterior of which a ganglion is seen, like the ganglion of the spinal nerves. The branches of the Vth

nerve are universally distributed to the head and face; but the anterior root goes only to the third division.

2 2 Branches of the *Suboccipital* Nerves, which have double origins and ganglions on the posterior roots.

3 3 The branches of the four inferior Cervical Nerves and of the first Dorsal, forming the Axillary Plexus: the origins of these nerves are similar to those of the Vth and the Suboccipital.

4 4 4 4 Branches of the Dorsal Nerves, which also arise in the same manner.

5 5 The Lumbar Nerves.

6 6 The Sacral Nerves.

OF THE IRREGULAR NERVES.

EXPLANATION OF THE PLAN, PLATE II.

The third, fourth, sixth, and ninth nerves, I have classed with the irregular nerves, as not having the double root and ganglion which characterise the thirty-one enumerated as regular; and surely it must be a satisfactory thing to notice why these nerves have only single roots, and are deficient in the sensitive root; it is because the parts to which these nerves are distributed are supplied by the fifth, the source of sensibility. So that if the proofs were not already sufficient, both from anatomy and experiment, of the correctness of our arrangement, this circumstance would be almost conclusive, that no nerve which goes to a part supplied by the fifth has a sensitive root. Now as to those irregular nerves, that is to say, nerves with single roots, which belong to respiration.

The observation of the frame of man or of brutes, and especially the review of it in a state of high activity, or under the influence of passion, will convince us that the motions dependent on respiration extend almost over the whole body, while they more directly affect the trunk, neck, and face. We may perceive, also, that during the involuntary action of respiration the same muscles are in operation as in the voluntary actions. This is evident not only in breathing, but also in coughing, sneezing, crying, laughing, speaking, swallowing, and vomiting; for all these are states or conditions of the respiratory nerves and muscles. In every effort but that of simple voluntary motion, the respiratory organs become the agents; and even in violent voluntary efforts, or the long continuance of exercise, the instinctive motions chime in with the voluntary motions, and the activity of the frame becomes general.

Under the class of respiratory motions we have to distinguish two kinds: first, the involuntary, or instinctive; secondly, those which accompany an act of volition. We are unconscious of that state of alternation of activity and rest which characterises the instinctive act of breathing in sleep; and this condition of activity of the respiratory organs we know, by experiment, is independent of the brain. But, on the other hand, we see that the act of respiration is sometimes an act of volition, intended to accomplish some other operation, as that of smelling or speaking. I apprehend that it is this compound operation of the organs of breathing which introduces a certain degree of complexity into the system of respiratory nerves. A concurrence of the nerves of distinct systems will be found necessary to actions which at first sight appear to be very simple acts of the will.

To make this evident, before proceeding further, I shall give an example of the necessity of this combination of different powers. Let us observe, in the act of eating and swallowing, the combination of the three powers of sensation, voluntary muscular activity, and the act of the respiratory muscles.

If we cut the division of the fifth nerve which goes to the lips of an ass, we deprive the lips of sensibility: so that when the animal presses the lips to the ground, and against the oats lying there, he does not feel them; and consequently he makes no effort to gather them. If, on the other hand, we cut the seventh nerve where it goes to the lips, the animal feels the oats, but he can make no effort to gather them, the power of muscular motion being cut off by the division of the nerve. Thus we perceive that in feeding, just as in gathering any thing with the hand, the feeling directs the effort; and two properties of the nervous system are necessary to a very simple action.

In drinking, the fluid is sucked in by the breath, and when the mouth is full we swallow. The water is felt; the lips are moulded into the right form by volition, and the muscles of inspiration combine to draw in the fluid. In the act of swallowing, the liquid would descend into the windpipe were there not a combination of the muscles of respiration with the apparatus of deglutition to prevent it; nor could the fluid or the solid morsel pass along the œsophagus through the diaphragm without a similar coincidence of activity and relaxation between parts animated by different systems of nerves.

In speaking, it is still more obvious that the act of respiration must become voluntary, in order to push out the breath in combination with the contractions of the larynx, tongue, and lips, for producing sound, and more especially articulate language.

The respiratory system must be exercised under an instinctive and involuntary impulse, as in breathing during sleep and insensibility. But it must, at certain times, be associated with voluntary actions. By foreseeing this difficulty, we shall avoid the danger of pushing the investigation of the anatomy too far; or of throwing a doubt over important discoveries by attempting too much*.

After the investigation of the regular system of nerves of sensation and voluntary motion, the question that had so long occupied me, viz.—what is the explanation of the excessive intricacy of the nerves of the face, jaws, throat, and breast? became of easy solution. These nerves are agents of distinct powers; and they combine the muscles in subserviency to different functions.

As far as regard motion and sensation, the original and symmetrical nerves appear sufficient for the concatenation of the muscles. By them creatures feel pain, move and withdraw themselves from injury; they have sensation, and pursue their objects of desire. But these nerves are not capable of (that is to say, were not designed for) the vital act of respiration, far less for smelling, speaking, singing, laughing, in which several acts the respiratory system is brought into activity.

As animals rise in the scale of beings, new organs are bestowed upon them. And as new organs and new functions are superadded to the original constitution of the frame, new nerves are given also, with new sensibilities, and new powers of activity.

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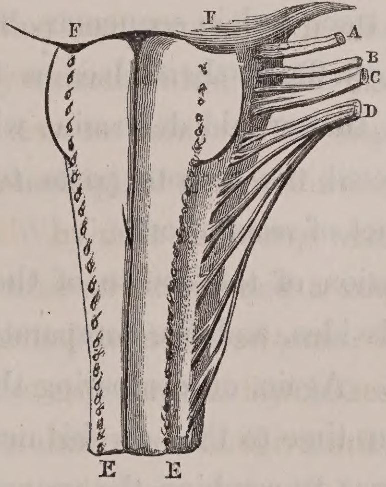
* There is a question remaining, What is the connexion between the encephalon and the spinal marrow: does the combination of voluntary muscles in walking or running result from an arrangement in the spinal marrow? The combination of the muscles in respiration obviously does. Whence then arises the power exercised by volition over these combinations? This is a subject touched upon in the third paper.

In the act of respiration we see a succession of regular motions extending over a great part of the animal machinery; we perceive that this is a new species of activity, and that this new energy must be derived from a source different from the locomotive powers. Looking to the simultaneous motions of the abdomen, thorax, neck, throat, lips, and nostrils, in breathing, it is obvious, in the first place, that they must be animated by nerves partaking of similar powers; and that these nerves must have a centre somewhere, so that they may be simultaneously and equally excited, and give a uniform impulse to the muscles of respiration.



A B C D are respiratory nerves, arising in a regular series of roots.

A Portio Dura.

B Glosso-pharyngeal.

C Par Vagum.

D Spinal Accessory.

In the line from E to F are the regular series of roots of the common muscular nerves.

The reader will now understand the course of my reflections, when I observed that there were certain nerves arising from a distinct column of the spinal marrow, not only different from the spinal nerves in being simple in their roots, but unlike either of the two roots of the spinal nerves; and that they had their origin in a row or regular series. After the course of the inquiry which I have described, it was natural to suppose that these nerves must have a distinct function, and what so probable as that pointed out by their course and distribution? viz.—that they were connected with the offices of respiration. Observing that the Spinal Accessory nerve, the Par Vagum, the Glosso-Pharyngeal nerve, and the Portio Dura of the seventh, arose in a distinct tract and in sequences, as in this outline, I conceived that they offered themselves as fair subjects for experiment, and that that would determine whether or not these four nerves connected the remote parts to which they were distributed in the act of respiration?

The consideration of the course of the Par Vagum gave countenance to this idea, and the comparative anatomy of the nerve confirmed it. Again, on comparing the experiments that had been made from time to time on this nerve, all conspired to show that its use was to combine the proper organs of respiration; while the other nerves were intended to draw the exterior apparatus of muscles into sympathy with the heart and lungs.

In this inquiry it was natural to ask why the Spinal Accessory of authors arose from the spinal marrow in the neck? why it ascended into the head, to join itself with the par vagum, instead of following the direct and short route to its destination in the muscles of the neck and shoulder, like the spinal nerves? The reason is this—The act of respiration being necessarily joined to the actions of the lips, tongue, larynx, and pharynx, and not in simple respiration only, but in speaking, swallowing, &c., it becomes necessary that the muscles of the neck and shoulders should be joined to those of the tongue, and larynx. For this purpose the spinal accessory, instead of going out directly through the vertebræ, ascends and interchanges filaments with the eighth, ninth, glosso-pharyngeal, &c. I divided its branches in the living animal, and by that means certain muscles of the neck were cut off from partaking in the act of breathing, while they retained their office under the other nerves; that is, they remained under the direction of the will when they had ceased to be influenced in respiration.

Directed in the next place to the Portio Dura, I wished to answer the question, Why does the nerve which supplies certain muscles of the face take an origin and a course different from the Fifth Nerve destined to the same parts? Guided by these considerations in my experiments, by inference I concluded, that on cutting across this nerve all the motions of the face connected with respiration ceased; and that it had the origin we see, and took its course with the respiratory nerves, because it was necessary for the association of the muscles of the nostrils, cheek, and lips, with the other muscles used in breathing, speaking, &c. For this reason it was associated with the root of the Eighth Pair instead of with the Fifth.

The inquiry into the functions of the branches of the Portio Dura which go to the eye-lids, led me to make observations on the motions of the eye-ball; and finally directed me to the Fourth Nerve to account for the sympathetic motions of the eye-ball in combination with the other parts moved in the excited state of respiration.

I must frankly own that this is the weak part of my system. There is a connexion in the functions of the nerves, but I cannot as yet satisfactorily trace back the origin of the Fourth Nerve to the respiratory column, although we may see that it comes in the due direction. This intricate subject is discussed in the paper the last but one in this volume.

Nothing can better prove the importance of the principles laid down in the beginning of this exposition than the explanation which it offers of the seeming intricacy of the nerves of the orbit and of the whole head and face; and the variety of curious facts which it brings to light.

It appears, then, that there are four nerves coming out of a tract or column of the spinal marrow, from which neither the nerves of sensation nor of common voluntary motion take their departure. Experiment further proves, that these nerves excite motions dependent on the act of respiration. There can be no hesitation or doubt that as far as the neck, throat, face, and eyes depend on, or are related to the actions of respiration, it is through these nerves that they are so associated.

I have been always desirous of stating, that the absolute proofs stop here, and that the rest is hypothesis. I imagine that the same column or tract which gives origin to the fourth, seventh, glosso-pharyngeal, par vagum, and spinal accessory nerves is continued downward along the lateral parts of the spinal marrow, and that it affords roots to the spinal nerves, constituting them respiratory nerves as well as nerves of motion and sensation; and that it especially supplies the roots of the diaphragmatic nerve, and the external respiratory nerve.

But this I cannot now demonstrate, and hardly hope to do. We see in the medulla oblongata three distinct columns, from each of which arise the roots of nerves possessed of distinct properties: a little further down we see no distinct respiratory nerves arising, whilst the motor and sensitive roots continue to take their origin in regular lines to the termination of the spinal marrow. It is more than probable that the respiratory column continues its course downward between the motor and sensitive columns, and bestows power on the compound spinal nerves.

The spinal nerves are adequate to the gentle and uniform motions of respiration, but not to the violent associated actions of respiration. Thus when a creature cries, or a man speaks or sings, the muscular effort is not in the muscles of the thorax only, and directed by the intercostal nerves; but the shoulders are raised and the thorax expanded by the influence of the spinal accessory nerve, and the external respiratory nerve; the larynx is excited by the branches of the par vagum called laryngeal; the cheeks, lips, and nostrils, are directed by the portio dura.

It appears, then, that it is the distance and the irregular position of the eye, nostril, mouth, throat and larynx, and muscles of the neck, which require these diverging and apparently irregular nerves to connect them with the act of respiration, and without which they would have possessed no more attributes than the nerves of the limbs; that is to say, sensibility and volition. But being accessories in violent excitement of respiration, they become the organs of expression in the motions of the countenance and chest and the sounds of the voice, and combine the instruments of articulate language.

EXPLANATION OF PLATE II.

A	Cavity of the skull.
B	Medulla Oblongata.
C C	Spinal marrow.
D	Tongue.
E	Larynx.
F	Bronchia.
G	Heart.
H	Stomach.
I	Diaphragm.

The third, sixth, and ninth nerves are not lettered, but only the following respiratory nerves.

1 1 1 Par vagum, arising by a single set of roots, and passing to the larynx, the lungs, heart, and stomach.

2 2 Superior laryngeal branches of the par vagum.

3 Recurrent or inferior laryngeal of the par vagum.

4 Pulmonic plexus of the par vagum.

5 Cardiac plexus of the par vagum.

6 Gastric plexus or corda ventriculi of the par vagum.

7 Fourth nerve, a nerve of this system to the eye.

8 Respiratory nerve or portio dura to the muscles of the face, arising by a single root.

9 Branches of the glosso-pharyngeal.

10 Origins of the superior external respiratory or spinal accessory nerve.

11 Branches of the last nerve to the muscles of the shoulder.

12 12 12 Internal respiratory, or the phrenic to the diaphragm. The origins of this nerve may be seen to pass much higher up than they are generally described.

13 Inferior external respiratory to the serratus magnus.

It was said that we understand the use of all the intricate nerves of the body, with the exception of the sixth. The sixth nerve stands connected with another system of nerves altogether; I mean the system hitherto called the sympathetic, or sometimes the ganglionic, system of nerves; and of this system we know so little, that it cannot be matter of surprise if we reason ignorantly on the connexion of the sixth with it.

On reviewing the whole nerves of the human body, the sensitive, motor, and respiratory systems combined, surely these views come strongly recommended. They present a series of facts unexampled for their number and importance. Such, for instance, as—1st, The distinct functions of the nerves of the face; 2d, The fact that all sensibility in the head and face depends solely on the fifth nerve; 3d, That the motions of the jaw depend on one of the roots of this nerve; 4th, The singular circumstance, that the common sensibility of the whole frame results from a series of ganglionic nerves extending the whole length of the spinal marrow; 5th, That the voluntary motions result from nerves arising in one line from the crura cerebri to the cauda equina, and having no ganglions upon them; 6th, That the act of respiration in the face, nostrils, throat, &c. results from a series of nerves differing from the common nerves; and last of all—7th, It will not be said that I have left the question unresolved with which I set out, viz., the cause of the intricacy of the nerves of the face, neck, and chest, since it has been shown that the same part, as for example the tongue, has different nerves suited to its different functions; and that the intricacy arises from the interweaving of the branches of different systems.

If there were no facts ascertained by experiment and the occurrences in practice, to give proof of the correctness of the views which I have presented, the simplicity of arrangement should be sufficient to recommend them.

I shall now lay before my reader the papers which I presented to the Royal Society on these subjects.

ON THE NERVES;

GIVING

A VIEW OF THEIR STRUCTURE AND ARRANGEMENT,
WITH THE ACCOUNT OF SOME EXPERIMENTS
ILLUSTRATIVE OF THEIR FUNCTIONS.

From the Philosophical Transactions, 1821.

ON THE NERVES, &c.

[*Read before the Royal Society, July* 12, 1821.]

During the general advancement of science which has lately taken place in this country, observations have been gradually accumulating in the school of Windmill-street, which prove that the department of anatomy has not been stationary. The nervous system, hitherto the most unsatisfactory part of the studies of the physiologist, has assumed a new character. The intricacies of that system have been unravelled, and the peculiar structure and functions of the individual nerves ascertained; so that the absolute confusion in which this subject was involved has disappeared, and the natural and simple order has been discovered.

In proceeding to give some account of these new observations, the author of this paper had conceived, that it would be more suitable to the scientific body he had to address, to lay the subject before them in the precise manner in which it first presented itself to his inquiries, and to detail his observations and experiments in the succession in which they were made; but he has been persuaded by some of the members of this × society to change that form, and to present the subject in the

× Captn Kater & Dr Thos Young. Ed 3rd 1836. Edinburgh manner which he has been accustomed to in teaching these doctrines; and they were pleased to say, that in this way a new subject would be more readily comprehended*.

Intricacy of the Nervous System.

Anatomists have of late, not only in this country, but also in Germany and Italy, made great improvement in the minute dissection and display of the nerves; but whilst the doctrines hitherto received prevail, the discovery of new branches of nerves, and new ganglions, only involve the subject in deeper obscurity. Whilst the nerves are supposed to proceed from one great centre, to have the same structure and functions, and to be all sensible, and all of them to convey what has been vaguely called nervous power, these discoveries of new nerves and ganglions are worse than useless; they increase the intricacy, and repel inquiry. The endless confusion of the subject induces the physician, instead of taking the nervous system as the secure ground of his practice, to dismiss it from his course of study, as a subject presenting too great irregularity for legitimate investigation or reliance.

When the physiologist sees two distinct nerves, spreading their branches to every part of the face (as in the Plate of these nerves), three nerves from different sources given to the tongue, four to the throat, and nerves in most perplexing intricacy to the neck; when he finds one nerve with numerous ganglions or knots upon it, and another without them; when, in short, after a minute dissection of the nervous system, he finds a mesh, or network, spreading everywhere, it is not surprising that the seeming intricacy and confusion should make him, in despair, resign inquiry. But the author being forced, in the course of his duty, to go minutely over the demonstration of the nerves, year after year, without allowing himself to resign the subject merely on account of its intricacy, and finding the facts which he had to explain in his demonstrations of the anatomy quite inconsistent with the received opinions, he has gradually, after much study, been enabled to decipher and to read that language, of which the character had hitherto been imperfectly known. And now even the youngest students are brought to comprehend so much of the subject, that the idea of chance or accident, or real confusion among these numerous branches, is entirely dismissed; and what remains unexplained has, by the success of our past inquiries, become a subject of peculiar interest, from the conviction, that attention to the minute anatomy, under the guidance of cautious and fair induction, will, sooner or later, lead to a comprehension of the whole system.

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* I believed that general attention to these subjects could not be raised by the account of a system founded on anatomy, and on the minute distinctions in the origins of the nerves. I thought that it required the announcement of some distinct and remarkable facts.

Statement of the object of the paper.

The author means to limit his present inquiry to *the nerves of respiration.* But according to his conception of this matter, these nerves form a system of great extent, comprehending *all* *the nerves which serve to combine the muscles employed in the act of breathing and speaking.*

The first point of inquiry naturally is, how many of the muscles are combined in the act of respiration? and the second question, by what means are these muscles, which are seated apart from each other, and many of them capable of performing distinct offices, combined together in respiration? It may sound oddly to speak of the respiratory nerve of the face, of the neck, and of the shoulder; and it may be necessary to give an illustration of the sense in which the term is intended to be employed. When a post-horse has run its stage, and the circulation is hurried and the respiration excited, what is his condition? Does he breathe with his ribs only; with the muscles which raise and depress the chest? No. The flanks are in violent action; the neck as well as the chest are in powerful excitement; the nostrils as well as the throat keep time with the motion of the chest. So if a man be excited by exercise or passion, or by whatever accelerates the pulse, the respiratory action is extended and increased; instead of the gentle and scarcely perceptible motion of the chest, as in common breathing, the shoulders are raised at each inspiration, the muscles of the throat and neck are violently drawn, and the lips and nostrils move in time with the general action; if he does not breathe through the mouth, the nostrils expand, and fall in time with the rising and falling of the chest; and that apparatus of cartilages and muscles of the nose (which are as curious as the mechanism of the chest, and are for expanding these air tubes), are as regularly in action as the levator and depressor muscles of the ribs.

It is quite obvious, that some hundred muscles thus employed in the act of breathing, or in the common actions of coughing, sneezing, speaking, and singing, cannot be associated without cords of connexion or affinity, which combine them in the performance of these actions: the nerves which serve this purpose, I call respiratory nerves.

The nerves of the animal frame are complex, in proportion to the variety of functions which the parts have to maintain.

When we minutely and carefully examine the nerves of the human body, and compare them with those of other animals, a very singular coincidence is observed between the number of organs, the compound nature of their functions, and the number of nerves which are transmitted to them. No organ which possesses only one property or endowment has more than one nerve, however exquisite the sense or action may be; but if two nerves, coming from different sources, are directed to one part, this is a sign of a double function performed by it. If a part, or organ, have many distinct nerves, we may be certain that, instead of having a mere accumulation of nervous power, it possesses distinct powers, or enters into different combinations, in proportion to the number of its nerves. The knowledge of this circumstance gives new interest to the investigation of this part of anatomy.

Thus, in reviewing the comparative anatomy of the nerves of the mouth, we shall find, that in creatures which do not breathe, the mouth having only one function to perform, one nerve is sufficient. In certain animals, where the face and nostrils have no complexity of relations, these parts have only a single nerve. If the throat has no complexity of organization, it has no variety of nerves. But on the other hand, when the anatomist employs weeks to dissect and disentangle the nerves of the tongue, throat, and palate, in the human subject, he finds at length, that he has exhibited the branches of five different trunks of nerves; and there is no clue to the labyrinth, until he considers the multiplied offices of the mouth in man; that it is a pneumatic as much as a manducatory organ; that it is the organ of the voice and of speech, as of taste and exquisite feeling. It would, indeed, be matter of surprise, if the same nerve served for the action of gnawing and feeding in the lower animals of simple structure, and also for the governance of those complicated operations, which serve to interpret the wants and sentiments of man.

Such are the views which naturally arise, from an acquaintance with the nerves of the human body; but a comparison of them, with those of the lower classes of animals, enables us to establish a more lucid order; and that not in an arbitrary manner, but perfectly according to nature.

The nerves may be divided into two parts, or systems; the one simple and uniform, the other irregular and complex, in proportion to the complexity of organization.

When the nerves of the face, mouth, throat, and neck of the human subject are minutely displayed, it seems impracticable to reduce the numerous nerves which cross and entwine with each other to two distinct classes; yet nothing is more certain than that this may be done, and by an easy and natural method.

The principle which is to guide us, is obtained by ascertaining what parts of the organization of an animal are necessary to life and motion; what organs are superadded as the animal advances in the scale of existence, and are necessary to higher and more complex enjoyments and actions.

Where an animal is endowed with mere sensation and locomotion, where there is no central organ of circulation, and no organ of respiration but what is generally diffused over the frame, the nerves are extremely simple; they consist of two cords running in the length of the body, with branches going off laterally to the several divisions of the frame. And here no intricacy is to be seen, no double supply of nerves is to be observed, but each portion of the frame has an equal supply; and the central line of connexion is sufficient to combine the actions of the muscles, and to give them the concatenation necessary to locomotion. × Mr Newport's dissection of Lobster nerve (Phil Trans) acknowledged here in 3rd Edn

There is the same uniform and symmetrical system of nerves in the human body as in the leech or worm; although obscured by a variety of superadded nerves. These additional nerves belong to organs, which, tracing the orders of animals upwards, are observed to accumulate gradually until we arrive at the complication of the human frame. These nerves, additional and superadded to the original system, do not destroy, but only obscure that system; and accordingly, when we separate certain nerves, the original system of simple constitution is presented even in the human body.

The nerves of the spine, the tenth or sub-occipital nerve, and the fifth or trigeminus of the system of Willis, constitute this original and symmetrical system*. All these nerves agree

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* The following note is from a paper by Mr. Shaw. To those who have interested themselves in these discoveries, during their progress, I need not say how much I am obliged to him, and with what ability he has advocated my opinions. Often I have felt satisfied with ascertaining the facts, when he has excited me to further inquiry, and to shape them for the public.

" *Comparison between the Fifth and the Spinal Nerves.*

" 1. That the head and face, having many parts in every respect similar to the neck, trunk, and limbs, must have corresponding nerves.

" 2. That the manner in which the spinal nerves and the fifth arise by double origins, is very similar.

" 3. That the ganglion on the root of the fifth nerve, has a strict resemblance to the ganglions at the origin of the spinal nerves.

" 4. That the manner in which the branches of the fifth are distributed, and those of the spinal nerves, is the same.

" And, lastly, with reference to the anatomy, we find that the same kind of connexion exists between the fifth and the sympathetic, as between the latter and the spinal nerves. In their morbid affections, the similarity also holds good: thus, in the common cases of hemiplegia, the spinal nerves and the branches of the fifth are similarly affected. In this disease, the voluntary power over the limbs, and the sensibility of the side affected, are generally destroyed; while in some cases the voluntary power is lost, and the sensibility continues unimpaired, or *vice versa.* This variety also occurs on the face; for the jaw will drop, and there will be all the marks of paralysis, while the sensibility of the skin and the sense of taste continue entire.

" In experiments on the nerves of the spine and on the fifth, we meet with the same results. If, as in the operation, which is now frequently performed on the nerves of the horse's foot, we cut a spinal nerve after the branches are given off to the muscles moving the part, we shall destroy only the sensibility of that part; but, if we cut the nerve nearer to the brain, we shall not only destroy the sensibility, but in these essential circumstances; they have all double origins; they have all ganglions on one of their roots; they go out laterally to certain divisions of the body; they do not interfere to unite the divisions of the frame; they are all muscular nerves, ordering the voluntary motions of the frame; they are all exquisitely sensible; and the source of the common sensibility of the surfaces of the body: when accurately represented on paper, they are seen to pervade every part; no part is without them; and yet they are symmetrical and simple as the nerves of the lower animals. See Plate I.

If the nerves be exposed in a living animal, those of this class exhibit the highest degree of sensibility; while, on the contrary, nerves not of this original class or system are comparatively so little sensible, as to be immediately distinguished; in so much that the quiescence of the animal suggests a doubt, whether they be sensible in any degree whatever. If the *fifth nerve, and the portio dura of the seventh*, be both exposed on the

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also the power of motion. The same happens in experiments on the fifth; for, if we cut a branch which is distributed principally to the skin of the lips, we shall destroy the sensibility of the part, but impair the power of mastication only in a slight degree; but if we divide the nerve further back, then we shall not only destroy the sensibility of the skin, as in the first experiment, but also cut off the power by which the jaws are moved. I cut a branch of the fifth upon the face; the sensibility of the corresponding side of the lip was destroyed, but little paralysis ensued. I cut the nerve nearer the brain, and at a point previous to its having given off the branches to the muscles; then the jaw fell, and the muscles of that side were powerless. I varied the experiment, by irritating the nerve where it lies in the spheno-palatine fissure, immediately after an animal was killed; the jaws then came together with much force, indeed, so as to nip my assistant's finger severely. This last experiment may be compared with the very common one of galvanizing the nerves which pass from the spinal marrow, to supply the muscles of the extremities."

face of a living animal, there will not remain the slightest doubt in the mind of the experimenter which of these nerves bestows sensibility. If the nerve of this original class be divided, the skin and common substance are deprived of sensibility; but if a nerve not of this class be divided, it in no measure deprives the parts of their sensibility to external impression.

More particularly of the respiratory nerves.

The nerves which connect the internal organs of respiration with the sensibilities of remote parts, and with the respiratory muscles, are distinguished from those of which we have been speaking by many circumstances. They do not arise by double roots; they have no ganglions on their origins; they come off from the *medulla oblongata* and the upper part of the spinal marrow; and from this origin, they diverge to those several remote parts of the frame, which are combined in the motion of respiration. These are the nerves which give the appearance of confusion to the dissection, because they cross the others, and go to parts already plentifully supplied from the other system.

The following are the nerves to be enumerated as *respiratory nerves*, according to their functions.

1. *Par vagum*, VIII. g. g.*, the eighth of Willis, the *pneumogastric nerve* of the modern French physiologists. This nerve goes off from the common origin of the respiratory nerves, the lateral

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* These letters have reference to plate 4.

part of the *medulla oblongata:* it takes its course to the larynx, the lungs, the heart, and stomach. It associates these organs together, which are at the same time supplied with nerves from other sources. Comparative anatomy would lead us to infer that this nerve is not essential to the stomach, as it does not exist but where there are heart and lungs to associate with a muscular apparatus of respiration. That the stomach must be associated with the muscular apparatus of respiration, as well as the lungs, is obvious, from the consideration of what takes place in vomiting and hiccough, which are actions of the respiratory muscles excited by irritation of the stomach.

2. *Respiratory nerve of the face*, (VII. plate 4. A. plate 6.) being that which is called *portio dura* of the seventh. This nerve, like the last, goes off from the lateral part of the *medulla oblongata*, and, escaping through the temporal bone, spreads wide to the face. All those motions of the nostril, lips, or face generally, which accord with the motions of the chest in respiration, depend solely on this nerve. By the division of this nerve, the face is deprived of its consent with the lungs, and all expression of emotion. This part of the inquiry will be found very interesting.

3. *Superior respiratory nerve of the trunk*, (h. plate 4. C. plate 6.) being that which is called *spinal accessory*. This nerve has exceedingly puzzled anatomists, from the singular course which it pursues. It arises from the superior part of the spinal marrow, in a line with the roots of the other respiratory nerves.

Instead of going directly out between the vertebræ, as the regular spinal nerves do, it passes up into the skull, comes out through the skull with the par vagum, and, descending upon the neck, goes to the muscles of the shoulder. In this course it supplies muscles, which are already profusely supplied by the regular system of nerves.

This nerve controls the operations of the muscles of the neck and shoulder in their office as respiratory muscles, when, by lifting the shoulders, they take the load from the chest, and fix the farther extremities of the muscles of inspiration seated on the thorax, so as to give them greater power over the ribs. When it was cut across in an experiment, the muscles of the shoulder ceased to co-operate as respiratory muscles, but remained capable of voluntary actions.

4. *Great internal respiratory nerve*, E. The *phrenic* or *diaphragmatic*, of authors. (See plates 2, 6, and 9.) This is the only nerve of the system which has been known as a respiratory nerve. Its origin, course, and destination, are so familiar to every one, that I shall not say anything more of it here. But there is another nerve, which has a remarkable resemblance to it, and which, from circumstances already noticed, has been entirely overlooked. This is,

5. *The external respiratory nerve.* (See plates 2 and 9.) This has a similar origin with the preceding nerve. It comes out from the cervical vertebræ, and is connected with the phrenic nerve. It runs down the neck, crosses the cervical and

axillary nerves, passes through the axilla, and arrives on the outside of the ribs, to supply the serratus magnus anticus, which, it is scarcely necessary to observe, is a muscle already supplied by nerves coming out between the ribs, from the system of regular nerves.

These four last-mentioned nerves govern the muscles of the face, neck, shoulders, and chest, in the actions of excited respiration, and are absolutely necessary to speech and expression. But there are other nerves of the same class, which go to the tongue, throat, and windpipe, no less essential to complete the act of respiration. These are the glosso-pharyngeal nerve, and the branches of the par vagum to the superior and inferior larynx*.

We proceed to examine these nerves in detail; and, first,

Of the nerves of the face, in which it is shown that the two sets of nerves, hitherto supposed to be similar, differ in structure, sensibility, and function†.

It is in the face that we have the best opportunity of observing the subservience of the nerves to the uses of the parts, and of ascertaining the truth of the preceding doctrines. The human countenance performs many functions possessed by the lower creatures: in it we have combined the organs of mastication, of breathing, of natural voice and speech, and of expression. Here also are seen signs of emotions, over which we have but a

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[*] It will be seen that, in the further investigation of this subject, the fourth nerve was discovered to be connected with this system.—See the paper on the Nerves of the Orbit.

[†] This subject is illustrated by plate 6. which represents the nerves of the face.

very limited or imperfect control: the face serves for the lowest animal enjoyment, and partakes of the highest and most refined emotions. Happily for our present object, the nerves, which in other parts of the frame are bound together for the convenience of distribution to remote parts, are here distinct, and run apart from each other until they meet at their extremities. They take different courses through the bones of the head, and come out upon the face, to be exposed in a manner which courts inquiry.

The nerves of the face are, first, the *trigeminus*, or the fifth of Willis, and that familiarly called the *portio dura* of the seventh, but which, in this paper, will be called *the respiratory nerve of the face.*

Of the trigeminus, or fifth pair.

In all animals that have a stomach, with palpi or tentacula to embrace their food, the rudiments of this nerve may be perceived; and always in the *vermes*, that part of their nervous system is most easily discerned, which surrounds the œsophagus near the mouth. If a feeler of any kind project from the head of an animal, be it the antenna of the lobster or the trunk of an elephant, it is a branch of this nerve, which supplies sensibility to the member*. But this is only if it be a simple organ of

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* The branches of the fifth pair enter the roots of the whiskers of the cat kind, these being feelers, and requiring branches of the sensitive nerve. The following is from a paper by Mr. Shaw:—

"In the cat, and in the hare, the branches of the fifth pass not only to the muscles, but also into the whiskers; while the branches of the facial respiratory nerve go past the hairs, and enter into the muscles, moving the tip of the nostril. It is rather difficult to demonstrate the nerves going into the bulbs of the hairs in these feeling, and is not in its office connected with respiration. The trunk of the elephant is not a simple feeler, it is a tube through which it respires, and therefore it has another nerve.

From the nerve that comes off from the anterior ganglion of the leech, and which supplies its mouth, we may trace up through the gradations of animals a nerve of taste and manducation, until we arrive at the complete distribution of the fifth, or trigeminus in man. (See plate 6. in which there are its three grand divisions to the face.) Here in the highest link, as in the lowest, the nerve is subservient to the same functions. It is the nerve of taste, and of the salivary glands; of the muscles of the jaws, and of common sensibility. This nerve comes off from the base of the brain in so peculiar a situation, that it alone, of all the nerves of the head, receives roots both from the column of sensibility and of motion. A ganglion is formed upon it near its origin, though some of its filaments pass on without entering into the ganglion. Before passing out of the skull, the nerve splits into three great divisions, which are sent to the face, jaws, and tongue. Its branches go minutely into the skin, and enter into all the muscles, and they are especially profuse to the lips*.

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smaller animals, but it is easily done in the phoca. A preparation illustrative of this fact was shown to me some years ago in Amsterdam, by Professor Vrolich; and in the first number of the *Journal de Physiologie Expérimentale*, by M. Magendie, there is an account of "les Nerfs qui se portent aux Moustaches du Phoque," by M. Andral. This fact of anatomy, which has been denied by some, is farther demonstrated by the dissection of those animals which have tufts of hair or whiskers over the eye. In the American squirrel, I have traced the branches of the first division of the fifth into the bulbs of the hairs over its eyebrow."

* We refer the reader to the next paper and the explanation of the plates for the more minute anatomy of this nerve.

*Of the respiratory nerve of the face, being that which is called portio dura of the seventh**.

This nerve does not exist, except where there is a necessity for some consent of motions to be established between the face and the respiratory organs; and the reason of its circuitous and prolonged course is, that it may associate with the other nerves of respiration. In fishes, this nerve, instead of being distributed forward to the face, passes backward to the muscles of the gills. In fact, there is, properly, no *portio dura* of the seventh in fishes, the nerve resembling it being a branch of the *par vagum*. A short description of this nerve in the human body will be necessary to our inquiry.

The respiratory nerve of the face arises from the superior and lateral part of the *medulla oblongata*, close to the *nodus cerebri*, and exactly where the *crus cerebelli* joins the *medulla oblongata*. The other respiratory nerves, which form so distinguished a part of the nervous system, arise in a line with the roots of this nerve.

The nerve, passing into the internal auditory foramen, is here embraced by the *portio mollis;* but it separates from it, and is received into an appropriate canal of the temporal bone. A little farther on, and while within the temporal bone, two cords of communication are formed with the branches of the fifth nerve, or *trigeminus*. One of these is called Vidian nerve, and the other *corda tympani*. By these communications, nerves go in both directions; branches of the seventh are sent to the muscles at the back of the palate; while branches of the fifth nerve (and also of the sympathetic nerve) are brought into the interior of the ear.

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* *Portio dura nervi acustici. Sympatheticus parvus* by Winslow, *Faciale* by Vicq. d'Azyr.

By the second of these communications, the *corda tympani*, [which joins the lingual branch of the fifth, just where that nerve is passing by the side of the *levator* and *circumflexus palati*,] the branches of this respiratory nerve have access to the *velum palati* and its muscles.

The respiratory nerve of the face, emerging through the stylomastoid foramen, divides into many branches, and these diverging, spread to all the side of the face. Let it be recollected, however, that it is here joined by branches of the third division of the fifth nerve*. The respiratory nerve having escaped from the temporal bone, divides: first, a branch is sent to the muscles of the outward ear; another is sent, under the angle of the jaw, to the muscles of the throat. The principal nerve then passes through the parotid gland, and comes upon the face. Here the branches continue to scatter, to go upwards upon the temple and downwards upon the side of the neck, forming on the neck a superficial plexus. The principal branches, however, go forward to the muscles of the forehead and eyelids; a branch called superior facial is sent to the muscles of the cheek and the side of the nose; while an inferior facial branch is given to the angle of the mouth, and the muscles which concentrate there.

In this extensive distribution, the nerve penetrates to all the muscles of the face; muscles, supplied also with the branches of the fifth pair.

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* See plate 7.

The descending or inferior divisions, which go under the lower jaw, and to the superficial muscles of the throat and neck, are connected with branches of the spinal nerves, and with the respiratory nerves, as may be seen in plate 6.

The proportion of the facial respiratory nerve to the fifth, is greater in man than in any other animal. If we descend to the next link in the chain of beings (the monkey), we shall find the proportion of it to be much diminished, and that of the fifth increased. The distribution of the nerve is more complicated in the monkey than in the dog, its intricacy being apparently in proportion to the number of the muscles of expression. From the lion, the dog, and cat, we descend to the horse, ass, and cow: in these animals there is a marked difference in the distribution of the nerve, from that of either the monkey or the dog; for, excepting a few branches, which pass to the muscles of the external ear, and to the eyelid, the whole of the respiratory nerve is confined to the muscles of the nostrils and side of the mouth, while in the carnivorous tribes it is spread in great profusion over the cheeks and side of the neck.

There are, however, some varieties in the classes of graminivorous animals. In the gazelle, sheep, and deer, the distribution of the nerve is still more simple than in the horse; while in the camel it is more profuse, and is, in this respect, intermediate between that of the carnivorous and the graminivorous animals. The expression of the enraged camel is sufficiently ferocious; and the manner in which he shows his tusks, when dying, is very similar to that of a carnivorous creature.

If we were barely to consider this distribution of the *portio* *dura* of the seventh, unbiassed by theory or opinion, we should be forced to conclude, that it is not alone sufficient to supply any one part with nervous power, for every one of its branches is joined by divisions of the fifth. The question then naturally arises, whether these nerves perform the same function? whether they furnish a double supply of the same property or endowment, as so many of our best authorities have supposed? or do they perform different offices? Having taken all the assistance that the knowledge of the human structure and comparative anatomy affords, we are prepared to decide the matter by experiment.

Experiments on the nerves of the face, with a view of ascertaining the uses of the portio dura.

If an ass be thrown, and its nostrils confined for a few seconds, so as to make it pant and forcibly dilate the nostrils at each inspiration, and if the *portio dura* be now divided on one side of the head, the motion of the nostril of the same side will instantly cease, while the other nostril will continue to expand and contract in unison with the motions of the chest.

On the division of the nerve, the animal will give no sign of pain; or in no degree equal to what results from dividing the fifth nerve [*].

If an ass be tied and thrown, and the superior maxillary branch of the fifth nerve exposed, touching this nerve gives acute pain. When it is divided, no change takes place in the motion of the nostril; the cartilages continue to expand regularly in time with the other parts which combine in the act of respiration. If the same branch of the fifth be divided on the opposite side, and the animal let loose, he will not pick up his corn: the power of elevating and projecting the lip, as in gathering food, appears lost. He will press the mouth against the ground, and at length lick the oats from the ground with his tongue. In my first experiments the loss of motion of the lips in eating was so obvious, that it was thought a useless cruelty to cut the other branches of the fifth[*].

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[*] In plate 7, branches of the fifth or sensitive nerve are seen to join and incorporate with the portio dura, so that the nerve, when cut anterior to this junction, must exhibit signs of sensibility.

The experiment of cutting the respiratory nerve of the face, or *portio dura*, gave so little pain, that it was several times repeated on the ass and dog, and uniformly with the same effect. The side of the face remained at rest and placid, during the highest excitement of the other parts of the respiratory organs.

When the ass, on which the respiratory nerve of the face had been cut, was killed by bleeding, an unexpected opportunity was offered of ascertaining its influence, by the negation of its powers on the side of the face where it was cut across.

When an animal becomes insensible from loss of blood, the impression at the heart extends its influence in violent convulsions over all the muscles of respiration; not only is the air drawn into the chest with sudden and powerful effort, but at the same instant the muscles of the mouth, nostrils, and eye-lids, and all the side of the face, are in a violent state of spasm. In the ass, where the respiratory nerve of the face had been cut, the most remarkable contrast was exhibited in the two sides of its face; for whilst the one side was in universal and powerful contraction, the other, where the nerve was divided, remained quite placid*.

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[*] The cases in the Appendix prove in a more agreeable way the fact, that when the facial branches of the fifth pair of nerves are cut, insensibility results without loss of motion. See No. LI., Appendix.

From these facts we are entitled to conclude, that the *portio dura* of the seventh is the respiratory nerve of the face; that the motions of the lips, the nostrils, and the velum palati, are governed by its influence, when the muscles of these parts are in associated action with the other organs of respiration. We cannot fail to acknowledge the necessity of this relation. These passages to the lungs are membranous tubes, moved by muscles, which serve to expand and widen them, so that the air may freely enter into the lungs. It is obvious that, to produce this expansion, these muscles must have a consent with the other muscles of respiration, and move simultaneously with them; and this is effected through the respiratory nerve of the face†. It shall be proved in the sequel, that the throat, neck, shoulders, and chest, have similar nerves to this, similar in distribution and function; and that these unite all the extended apparatus of breathing and speaking.

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* Read the case of Paralysis of the Face, No. VII. Appendix, where the expression of a woman in labour was confined to one side. A frightful expression of countenance was produced by the same cause in a patient dying.—See Case XXXIX.

† In Case No. X. in the Appendix, the defect from paralysis of the nostril is apparent. The same is shown in the detail of Daniel Quick's Case, No. III. A more curious example is presented in No. VI., where it is seen, that if the patient lay with the nostril of the sound side pressed against the pillow, he was under the necessity of actually holding the paralytic nostril open with his fingers, in order to breathe freely.

The actions of sneezing and coughing are entirely confined to the influence of the respiratory nerves. When carbonate of ammonia was put to the nostrils of the ass whose respiratory nerve had been cut, that side of the nose and face, where the nerves were entire, was curled up with the peculiar expression of sneezing; but on the other side, where the nerve was divided, the face remained quite relaxed, although the branches of the fifth pair and the sympathetic were entire. The respiratory nerve of one side of the face of a dog being cut, the same effect was produced; the action of sneezing was entirely confined to one side of the face.

These last experiments show, that the peculiar expression in sneezing results from an effect on the respiratory nerves, and that the muscles of the face are drawn into sympathy solely by the influence of the respiratory nerve of the face. It will appear that the property of receiving impression is not actually lost by the division of this facial muscular nerve, but the corresponding expression is quite destroyed*.

There is no part of the nervous system where the anatomy has been more negligently consulted in forming our physiological opinions, than in what regards the office of the sympathetic nerve. The connexions of this nerve, or rather system of nerves, being universal, it has been supposed that it was the cord through which the relations of the eye, nose, face, throat, diaphragm, &c., were established, and especially in expression; whereas the combination is effected solely through those nerves which, from their grand or leading function, I have called the respiratory nerves. The sympathetic nerve was left entire when the respiratory *portio dura* was cut, yet no sympathy pervaded the features. The sympathetic nerve is therefore not the source of that sympathy which produces expression.

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* See Daniel Quick's Case, Appendix.

It has been presumed, that the act of smiling is peculiar to the human countenance, and that in no other creature can there arise that state of enjoyment which produces this distinguishing character of the human face, the affection of benevolence, or the enjoyment of the ridiculous. But every one must have observed how near the approach is to this expression in a dog, when he fawns on his master, and leaps and twists his body and wags his tail, while at the same time he turns out the edge of the lips as like a laugh as his organs can express. When the respiratory nerve on one side of the dog's head was cut across, there was no longer this motion of the lips, although it was still observable on the other side, where the nerve was entire.

On cutting the respiratory nerve on one side of the face of a monkey, the very peculiar activity of his features on that side ceased altogether. The timid motions of his eye-lids and eyebrows were lost, and he could not wink on that side; and his lips were drawn to the other side, like a paralytic drunkard, whenever he showed his teeth in rage. Considering these facts, the conclusion is inevitable, that the motions of the lips, nostrils and eye-lids, and forehead, in expression, have nothing to do with the fifth pair of nerves, nor with the nervi molles, branches of the sympathetic nerve, which accompany the blood-vessels of the face.

In the Appendix we have proofs equal to experiments, that in the human face the actions of the muscles which produce smiling and laughing are a consequence of the influence of this respiratory nerve. A man had the trunk of the respiratory nerve of the face injured by a suppuration which took place anterior to the ear, and through which the nerve passed in its course to the face. It was observed, that in smiling and laughing, his mouth was drawn in a very remarkable manner to the opposite side. The attempt to whistle was attended with a ludicrous distortion of the lips: when he took snuff and sneezed, the side where the suppuration had affected the nerve remained placid, while the opposite side exhibited the usual distortion.

Thus it appears, that whenever the action of any of the muscles of the face is associated with the act of breathing, it is performed through the operation of this respiratory nerve, or *portio dura*. I cut a tumour from before the ear of a coachman: a branch of the nerve which goes to the angle of the mouth was divided. Some time after, he returned to thank me for ridding him of a formidable disease, but complained that he could not whistle to his horses*.

Thus it appears that the *portio dura* of the seventh nerve is the principal muscular nerve of the face; that it supplies the muscles of the cheek, the lips, the nostrils, and the eye-lids; that is, that it is the nerve which orders all those actions which have even the remotest connexion with the act of respiration. It is possible that those relations may not be apparent at first, but in the prosecution of this subject we shall discover the reasons of those links by which the respiratory organs are combined with the actions of the features.

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* Of this we have now abundant proofs:—see the cases in the Appendix. The only subject of surprise is that these circumstances should have been so long unobserved.

Of the functions of the Trigeminus, or fifth nerve.

As soon as the proper distinctions in the functions of these facial nerves are made, facts multiply upon us. We have seen that when the fifth nerve, the nerve of mastication and sensation, was cut in an ass, the animal could no longer gather his food. It was found, that on cutting the infra-orbitary branch of the fifth nerve on the left side, and the *portio dura*, or respiratory nerve, on the right side of an ass, the sensibility to pain on the right side, where the *portio dura* of the seventh nerve was cut, remained entire, while that of the left side was completely destroyed by the division of the fifth. It was also apparent in this experiment, as in the others, that there was the most marked difference in the sufferings of the animal, when these nerves were cut across. The cutting of the fifth nerve gave pain in a degree corresponding with our notions of the sensibility of nerves; but in cutting the *portio dura*, it was not evident that the animal suffered pain at all.

Independently of the difference of sensibility in these nerves, there was exhibited, in all these experiments, a wide distinction in their powers of exciting the muscles. The slightest touch on the *portio dura*, or respiratory nerve, convulsed the muscles of the face, whilst the animal gave no sign of pain. By means of the branches of the fifth nerve, it was not possible to excite the muscles, if the trunk of the nerve were divided; that is to say, if the communication with the sensorium were cut off.

I divided the branch of the fifth pair, which goes to the forehead, in a man, at his urgent request, on account of the *tic douloureux:* there followed no paralysis of the muscles of the eye-brow: but in an individual where an ulcer and abscess seated anterior to the tube of the ear affected the superior branch of the respiratory nerve, the eye-brow fell low, and did not follow the other when the features were animated by discourse or emotion*.

Facts multiply upon us daily, if our attention be kept awake by a knowledge of the anatomy of these nerves. I had a patient in whom there was loss of sensibility in the side of the face and tongue from disease of the fifth, while the motions of the features remained. The case is detailed in the Appendix, No. LVI. page cxii., and in the next paper†.

Thus experiments and occurrences in practice leave no doubt as to the distinct offices of the two nerves of the face; and that the fifth nerve is the sole cause or source of the common sensibility of the head and face.

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* This is more particularly illustrated by the division of the fifth nerve—see No. L. of the Appendix.

† See also the case of division of the suborbitary nerve, in No. LI. of the Appendix.

The following circumstance occurred to a very learned and ingenious gentleman. Suffering under the pangs of toothache, he took the sudden resolution of having his tooth drawn, and by an inexperienced hand: a grinder of the lower jaw was extracted. On putting a tumbler of water to his lips, he said, Why have you given me a broken glass? he found presently that the glass was entire, but that he had lost the sensation of one half of his lower lip. He thought that he put half a glass to his lips, because the lip had been deprived of sensation in one half of its extent. He retained the power of moving the lip, but not of feeling in it: and now, after some years, he does not know when a portion of food, or a drop, hangs on that side of the lip, although there be not the slightest impediment in its motions.

This circumstance is explained on reference to the plate, for there is a branch of the fifth nerve called *mandibulo-labralis*, coming through the jaw, to be given to the lip. This nerve was undoubtedly hurt where it takes its course in the jaw under the roots of the teeth, and the consequence was the loss of sensation in the one half of the lip which is supplied by it. It is equally important in this investigation to notice, that although the sensibility of the lip was destroyed by the injury of the branch of the fifth, the motion of the lip remained entire through the operation of the *portio dura*.

In the above statement there are some facts regarding the feeding of the animals which are of difficult explanation, until we consider what is necessary to the simple act of feeding. When a horse gathers the oats from the hand or from the ground, he must feel the food, which is the office of the branches of the fifth; he must move his lips under the direction of that feeling, or he cannot gather it. It was accordingly discovered by experiment, that whether the seventh or the fifth were cut, if the operation were done on both sides of the face, the creature was deprived of the power of feeding, but from different causes; for in the first experiment it was owing to the loss of motion, and in the second to the loss of sensation.

I am unable to decide whether or not the muscular branches of the fifth nerve go exclusively to the muscles of the jaws, and not at all to those of the cheeks. I have found in an individual, that, when the cheeks and lips were twisted by paralysis, he possessed the power of holding with his lips in a manner that indicated a power independent of the seventh. Now this might be a defect of one of the endowments of the seventh whilst another remained, or it might have been owing to a branch of the fifth going forwards to the buccinator. We shall not discuss this here, as it is the subject of the second paper*.

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* Mr. Shaw in a paper on this subject says, "In the case of a little girl, the consequence of disease of the right *portio dura* is very striking. When she laughs heartily, the right cheek and the same side of the mouth are unmoved, while the muscles of the left side are convulsed with laughter.

"If told to laugh with the right side, she raises the angle of the mouth, but by an action which is evidently regulated by the fifth pair. This attempt to laugh gives a peculiarly droll expression to her face." But before we decide on this matter, we must determine whether even the *portio dura* of the seventh nerve may not lose one faculty and retain another. I suspect that the influence of passion, as this of smiling or laughing, is lost in consequence of affections that do not destroy the entire power of the nerve.

"I have observed in one patient the motions of the eyelids lost, while those of the cheek remained; in another the motions of the cheek lost, while those of the eyelids

It will be asked, why a nerve called *respiratory* should go to the ear and the eye? First, let us inquire, does it belong to the frame of animal bodies that there shall be in them indications of passion? If it be admitted that this is the case, we here learn in addition, that as the *portio dura* is the nerve of respiration, so is it the grand nerve of expression, not only in man, but in brutes also. All that excitement seen in a dog's head, in his eyes and ears when fighting, disappears, if this nerve be cut. The respiratory nerve being cut across in a terrier, the side of the face was deprived of all expression, whether he was made to crouch, or to face an opponent and snarl. When another dog was brought near, and he began to snarl and expose his teeth, the face, which was balanced before, became twisted to one side, to that side where the nerve was entire; and the eyelids being, in this state of excitement, very differently affected, presented a sinister and ludicrous expression.

On cutting the respiratory nerve of the face in the carnivorous animals, it did not appear that the action of feeding was left so entire as in the graminivorous animals. This gave me reason to reflect on the different natures of the two classes. The beast of prey procures his food under the influence of a blood-thirsty appetite, and suffers a universal excitement; he holds and rends his prey; and especially in the larger animals of this class, the action of feeding is accompanied with horrific sounds of enjoyment; in short, with a highly excited state of the organs of respiration. In the graminivorous animals, the act of feed-

were entire. These symptoms still tend to show that one function of the *portio dura* may be lost without the other."

ing is a simple and unimpassioned exercise of the organs of mastication.

The author hopes that these experiments will be deemed conclusive; yet it is a pleasanter mode of investigation to have recourse to comparative anatomy. There is only one additional instance of this kind that he will offer. It has been already stated that when a feeler, or antenna, is examined, if it be simply for sensation, one nerve only runs along it. It was suggested to him, that if this theory were true, the trunk of the elephant being hollow, and connected with respiration, it should have two nerves; whereas, in the observations of Cuvier, it was stated to have only one; but on examination, it was found that large branches, nearly equal in size, of the *portio dura* and of the fifth took their course along the trunk *.

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* Mr. Shaw had an opportunity of dissecting the trunk of an elephant. He says, " From the great power which the elephant has over its trunk I was certain that there must be large nerves running to it, similar to those which supply the fingers in man; but as the proboscis forms an important part of the respiratory system of this animal, I thought in the dissection of it there would be the most distinct proof of the accuracy or fallacy of Mr. Bell's opinions on the subject of the *portio dura.*

" The trunk was found to be supplied not only by branches of the fifth pair, as described by Cuvier, but also by a very large branch from the *portio dura* of the seventh pair.

" The *portio dura* in this elephant was found emerging from the parotid gland, as in other mammalia. It gave off some descending branches to the neck, but passed from behind the jaw to the proboscis, almost as an entire nerve, and of the size of the sciatic nerve in man: in its course it only gave some small branches to the muscles of the eye, to those of the ear, and to a small muscle which corresponds with the platysma. Before it passed into the substance of the proboscis, it united with the second division of the fifth pair, which comes forward from the infra-orbital hole, in two large branches. The two nerves being then closely united, passed between the layers of the muscles, which form the greater mass of the trunk. The

SOME FURTHER REMARKS ON THE DISEASES OF THE NERVES OF THE FACE.

Were we to inquire no further, and to rest contented with the inference, that the two sets of nerves distributed to the face have distinct functions; even this must prove useful both to the surgeon and physician. To the surgeon it must be useful in performing operations on the face, as well as in observing the symptoms of disease. If we have to plan an incision on the face, we must take especial care to avoid cutting the branches of the seventh nerve, for if it be divided, there will be paralysis of the muscles supplied by that nerve. Whereas, if we divide the fifth nerve, though there may be more pain during the operation, and a defect of sensibility following it, no unseemly distortion will be produced. To produce paralysis as a consequence of an operation which was meant to remove deformity, is an unfortunate mistake; but even worse consequences may result from an ignorance of the distinct nature of these nerves: if, trusting to the eyelids being supplied by the branches of the fifth nerve, a surgeon, in opening an abscess or cutting out a tumour, should cut the division of the seventh which goes to the eyelids, the

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portio dura became quickly diminished in size, as it gave off its branches in great profusion to the muscles: but the fifth was continued down, as a very large nerve, to nearly the extremity of the trunk; in this respect resembling the nerves to the fingers in man. On making sections of the proboscis, near its extremity, a great number of these nerves were seen in its substance.

"A few branches of the *portio dura* ran to the valvular apparatus in the upper part of the trunk; but this peculiar structure was supplied principally by a branch from the fifth pair, which winded round under the orbit."

consequence would be very unfortunate. The eyelids thenceforward would stand apart, the eye would be permanently uncovered, and the cornea become opaque, and the vision of the eye be lost.

By a knowledge of the distinct functions of the nerves of the face, combined with a knowledge of their roots or origins in the brain, we become better able to comprehend symptoms when they are consequent on disease in the bones, or in the base of the brain, or result from injury to the skull or brain, as in the case of gun-shot wounds[*].

To the physician the facts ascertained in this paper must also be important: he will be better able to distinguish between that paralysis which proceeds from the brain, and that partial affection of the muscles of the face, when, from a less alarming cause, they have lost the controlling influence of the respiratory nerve. How often have I seen an inflamed gland affecting a branch of the *portio dura* mistaken for a disease in the brain itself, because it was not known that, although the fifth nerve was free, the pressure on the seventh nerve was sufficient to paralyze the muscles of the side of the face[†]. That the disease of the bone at one time affects the fifth nerve, producing excessive pain of the face without paralysis; and that it, at another time, affects the seventh nerve, inducing paralysis without pain, are now phenomena accounted for.

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[*] In the Appendix, Nos. 3. 40. 42. sufficiently prove the consequences of cutting across the *portio dura*, and that the surgeons must avoid dividing this nerve.

[†] In the Appendix, the cases Nos. 1, 2. 7, 8. 32. 34. 38. 41. 45. 52. 56. show the importance of this fact.

It is very frequent for young people to have what is vulgarly called a blight; by which is meant, a slight palsy of the muscles on one side of the face, and which the physician knows is not formidable. Inflammation of glands seated behind the angle of the jaw will sometimes produce this: before these observations, it would have been said, that paralysis could not be so produced, because the parts are plentifully supplied by the branches of the fifth nerve. The occurrence is stated at p. 4. 34. 62. of the Appendix. All such affections of the respiratory nerve will now be more easily detected, even in their most equivocal state: the patient has a command over the muscles of the face, he can close the lips, and the features are duly balanced; but the slightest smile is immediately attended with distortion, and in laughing and crying the paralysis becomes quite distinct.

The fact appears to be, that the respiratory motions of the face produced by the influence of this nerve are subject to derangement from slight causes; by causes which do not influence the general nervous system, nor even the other functions of the seventh nerve. We shall see in the third paper, that this character belongs to other branches of the same system in their distribution to the trunk.

The knowledge of the sources of expression teaches us to be more minute observers. The author had lately to watch the breathing of an infant which had been several times restored from a state of insensibility. At length the general powers fell low, without any returning fit; insensibility and loss of motion stole over the frame; all but the actions excited by the respiratory nerves ceased; then each act of respiration was attended with a twitching of the muscles of the *ala nasi*, and of that muscle of the cheek which makes the dimple in smiling. It was then evident that the child could not recover, that all but the system of respiratory nerves had lost their powers, and the consideration that these are the last to die showed too plainly that actual death approached.

There are conditions of the lungs, when the patient is in great danger, and yet the inflammation is not marked by the usual signs of pain and difficult motion of the chest. We shall see nothing but the twitching of those muscles of the face, which are animated by the respiratory nerve. We see a certain unusual dilatation of the nostrils, and a constrained motion of the lips, which, with the change of voice, is just sufficient to give alarm, and indicate the patient's condition. This is a state of the lungs very often produced after severe accidents, as gun-shot wounds, and after great surgical operations.

A patient being in extreme danger, however debilitated, we leave him in the conviction that death does not yet approach; but when the respiratory organs are agitated, then the act of dying has commenced.

These circumstances are stated to prove, that the subject of expression is not foreign to medical studies; and certainly, by attention to the action of the muscles of the face, we shall find the views drawn here from the anatomy farther countenanced. We learn that smiling is an affection of the nerve of respiration on the muscles of the face, and that when laughter shakes the sides, it is only an extended and more convulsive action of the muscles, produced by the same class of nerves. When to the paleness and coldness and inanimation of grief, there is added the convulsive sob and the catching of the throat, and the twitching of the lips and nostrils, we discover the same class of nerves to be affected, which, in crying, are only more obviously in operation, producing more violent contractions.

CONCLUSION.

When the account of the nerves of the throat, neck, and chest, shall be laid before the Society, as those of the face have now been, and when a comparison shall be made of the varieties in nerves corresponding with the changes in the mechanism of respiration in different animals, a juster estimate may be formed of the importance of these observations. Then the same distinctions of structure and function, which are made manifest in the nerves of the face, will be observed in nerves which take an extensive course through the body. We shall be able to distinguish and separate the nerves of respiration, amidst the apparent intricacy of the general system. By cutting across these nerves of respiration, we shall find it possible successively to stop the motions of the several parts, which unite in the act of respiration; not only to stop the motion of the diaphragm, but the motions of the side, of the shoulder, of the larynx or the pharynx, by cutting their respective respiratory nerves. When this is done, they will be left in the exercise of their other functions through their other nerves, and still alive to other excitements, and capable of performing the voluntary motions, though dead to the influence of the heart and lungs.

By thus distinguishing the nerves of respiration, and as it were separating them from the others, we reduce the remaining part of the nervous system to comparative simplicity. The seeming intricacy in the branching of the nerves, their convergence to certain organs from different origins, their re-union and divergence, instead of being a source of confusion, become a subject of the highest interest. The re-union and crossing of nerves we now ascertain to be for the purpose of associating the muscles into different classes, for combining them in subserviency to different organs, and placing them under the guidance of a sensibility more certain in its operation than the will.

And now it may be once more asked, why is the *portio dura,* the muscular nerve of the face, separated from the sensitive fifth pair? Is it an accidental circumstance? No, certainly: it is a dangerous principle to admit chance in a matter of this kind: it cannot be an accident, which directs a distribution so uniform through all the varieties of animals which breathe. It is ordered for the ends so often hinted at in these papers—that the organs in the face may be associated with those of the neck, larynx, pharynx, &c. The nerve separates from the fifth, and joins the glosso-pharyngeal and laryngeal, and the roots of the phrenic, that all the parts supplied by these may be joined together, and that a sympathy may exist among those parts which would remain disjoined were there no other nerves than the regular and symmetrical nerves of the spinal marrow.

A VIEW OF THE NERVES OF THE HEAD.

EXPLANATION OF PLATE VI.

In this plate the two distinct classes of nerves which go to the face are represented; the one to bestow sensibility, and the other motion, and particularly the motions of speaking and expression, that is, the actions connected with the respiratory organs.

The nerves on the side of the neck are also represented. These I have discovered to be double nerves, performing two functions: they control the muscular frame, and bestow sensibility on the skin. Besides these regular spinal nerves, which are for the common endowments, the nerves of the throat are represented. These latter nerves are the chords of sympathy which connect the motions of the neck and throat with the motions of the nostrils and lips; not merely in swallowing and during excited respiration, but in the expression of passion, &c.

A. The respiratory nerve of the face, or, according to authors, the *portio dura* of the seventh nerve.

a. Branches ascending to the temple and side of the head.
b. Branches which supply the eye-lids.
c. Branches going to the muscles which move the nostrils.
d. Branches going down upon the side of the neck and throat.
e. Superficial cervical plexus.

ff. Connexions formed with the cervical nerves.
g. A nerve to the muscles on the back of the ear.
B. The eighth nerve, par vagum, or grand respiratory nerve.
C. The superior respiratory nerve, or spinal accessory nerve.
D. Ninth nerve, or lingualis.
E. Diaphragmatic or phrenic nerve.
F. Sympathetic nerve.
G. Laryngeal nerve.
H. Recurrent laryngeal nerve.
I. Glosso-pharyngeal nerve.

I. Frontal nerve: a branch of the fifth.
II. Superior maxillary nerve: a branch of the fifth.
III. Mandibulo-labralis: a branch of the fifth.
IV. Temporal branches of the third division of the fifth.
V. Ramus buccinalis-labialis: a branch of the third division of the fifth, prolonged from the motor root.
VI. VII. VIII. IX. Spinal nerves.

ON THE NERVES OF THE FACE.

[*From the Philosophical Transactions.—Read May* 28, 1829.]

I HAVE to beg the indulgence of the Society to some minute details of anatomy, for the sake of those deductions which can be attained by no other means: and that a zeal for its cultivation may be preserved among us. There is an obvious practical benefit derived from anatomy, but the public do not comprehend its importance as a science. It is to the Royal Society that those who prosecute this science must look for countenance in their slow and painful investigations.

Nine years ago, at the request of our late President, I submitted to the Society a paper on the Nervous System; in which I arranged the nerves strictly according to the anatomy, and illustrated the principles of the arrangement, by exhibiting the different functions of the Nerves of the Face. On presenting a second paper on the same part of the nervous system after so considerable a lapse of time, there will be some novelty both in the facts and in the illustrations; yet I have more gratification in showing that after the most minute inquiries in different countries, my positions drawn from the anatomy have been admitted, and my reasoning on the experiments, with one exception, found to be correct. Confident in the accuracy of my deductions from the anatomy of the fifth nerve, I had attributed to one of its branches a function which belongs to another branch of the same nerve. The subject will form a part of the present paper.

After the announcement of the facts in my first paper, the inquiry became interesting from its application to medical practice. I must take another opportunity of thanking those gentlemen who have so liberally afforded additional proofs of the truth of my principles. I must restrict myself in referring to them here, since I am desirous that the Society's Transactions should contain only the philosophical part of the inquiry.

The system of Willis, of which we have an elegant account in the posthumous works of Dr. Baillie, prevailed universally in the schools when I entered on these inquiries. In opposition to that system I demonstrated that the nerves hitherto supposed to possess the same powers, consisted of filaments having different roots, and performing different functions. I found myself embarked in this investigation, from observing the course which the nerves took in their distribution through the body. Conceiving that the devious course and re-union of the nerves were for a purpose, I sought in their origins for the cause of their seeming irregularity. It was discovered that the roots of the nerves arose from distinct columns of nervous matter, and that on these columns depended their different properties. Those which were called the common nerves, that is, the nerves which arise from the spinal marrow, thirty in number, were found to consist each of two nerves derived from distinct columns, one for sensation and one for motion. In the further pursuit of this subject, there was reason to conclude that the spinal marrow contained not only the columns for bestowing sensation and motion, but also another column, the office of which was to combine the actions of respiration. I then drew the attention of the Society to the course of the fifth nerve of the brain according to Willis. I showed that it had the same double root as the spinal nerves, that it had a ganglion, and that part of the nerve passed free of the ganglion; and that from all these points of resemblance, it was to be considered as the anterior or superior of the spinal nerves, of that system which is called symmetrical, and which ministers to the same functions in all classes of animals, bestowing sensibility and the locomotive powers, but deficient in those filaments which command the respiratory motions. I am particular in restating this, because from time to time it has been reported that I had abandoned my original opinions; whereas every thing has tended to confirm them.

From the general view of the nervous system, I drew attention to the superadded or irregular nerves. Having shown that the original or symmetrical system of nerves, of which the fifth was one, had no power over the motions of respiration, and that the human countenance in all its motions, with the exception of mastication, bore relation to the actions of respiration, it was therefore required that another nerve besides the fifth should be sent to the face. Having shown also that the roots of the fifth nerve were distant from that column of nervous matter which gives origin to the nerves of the respiratory system, and that it could not therefore minister to the motions of the face which are connected with respiration; and that another nerve, the portio dura, having its root in common with the nerves of respiration, took its course to the face—the subject was prepared for experiment.

By experiments on the nerves of the face these three things were proved:—First, that the sensibility of the head and face depended on the fifth pair of nerves: secondly, that the muscular branches of the fifth were for mastication: and in the third place, it was proved that the portio dura of the seventh, or respiratory nerve of the face, controlled the motions of the features, performing all those motions, voluntary or involuntary, which are necessarily connected with respiration;—such as breathing, sucking, swallowing, and speaking, with all the varieties of expression.

Reserving the details, I shall now state shortly the occurrences which I have witnessed since the publication of that paper; as they afford convincing proofs of the correctness of these opinions.

The first instance was in a man shot with a pistol ball, which entered the ear and tore across the portio dura at its root. All motion on the same side of the face from that time ceased; but he continued in possession of the sensibility of the integuments of that side of the face.

The next instance was in a man wounded by the horn of an ox. The point of the horn entered under the angle of the jaw, and came out before the ear, tearing across the portio dura.

He remains now a singular proof of the effects of the loss of function in the muscles of the face by this nerve being divided. The forehead of the corresponding side is without motion, the eye-lids remain open, the nostril has no motion in breathing, and the mouth is drawn to the opposite side. The muscles of the face by long disuse are degenerated, and the integuments of the wounded side of the face are become like a membrane stretched over the skull. They have lost their firmness, and the flesh under them is wasted, with the exception of certain muscles; the reason of which will be understood on perusing the anatomical description in the present paper. In this man the sensibility of the face is perfect. The same nerve (portio dura) has been divided in the extirpation of a tumour from before the ear, and the immediate effect has been horrible distortion of the face by the prevalence of the muscles of the opposite side, but without the loss of sensibility; and that distortion is unhappily increased when a pleasurable emotion should be reflected in the countenance.

These facts are so distinct, that I cannot presume to detain the Society with the instances of the lesser defects which I have witnessed from the more partial injuries or temporary diseases of the nerve;—such as distortion of the features produced by glands pressing on this nerve, paralysis from suppurations in the ear affecting the nerve in its passage, or temporary derangement disturbing one or more of its functions.

As to the fifth nerve, the facts are equally impressive, and correspond with our former experiments and opinions. By a small sacculated tumour affecting the roots of this nerve, the sensibility was destroyed in all the parts supplied by its widely extended branches; that is, in all the side of the head and face and the side of the tongue, whilst the motion of the face remained. Two circumstances affecting this nerve have occurred with most curious coincidence in the symptoms. By the drawing of a tooth from the lower jaw, the nerve which comes out upon the chin to supply one half of the lip was injured, and exactly this half of the lip was rendered insensible. When the patient put his mouth to a tumbler he thought they had given him a broken glass! Precisely the same thing occurred from the division of that branch of the fifth nerve, which goes to one half of the upper lip. A gentleman falling, a sharp point entered his cheek and divided the infra-orbitary nerve: the effect was loss of sensation without loss of motion, in that half of the upper lip to which the nerve is distributed. The remarkable circumstance was, that this individual made the same remark when the cup was put to his lip;—that they had given him a broken one! The part of the cup which was placed in contact with the insensible portion of the lip appeared to him to be broken off.

I have had two or three instances before me of disease affecting the ophthalmic branch of the fifth nerve, and producing total insensibility of the eye and eye-lids, without loss of vision; whilst the eye-lids continued to be closed and the eye-brow to be moved by the influence of the portio dura of the seventh nerve.

Such are a few of the facts which have been reaped from a patient reliance on the correctness of my first deductions, and I would now urge them in proof of the importance of reasoning upon the anatomy. All these nerves have been repeatedly divided, by almost every surgeon of eminence in the three kingdoms. Although some have performed the operation of dividing the nerves frequently, and one eminent gentleman had done it six times on the face of the same man, all these operations have been performed without giving rise to the suspicion that these nerves bestowed different properties. Even now, so slow is the progress of improvement, it is stated by a surgeon that he will not hesitate to cut the portio dura in the case of tic douloureux. My duty is performed when I give publicity to the facts which prove that horrible distortion of the whole countenance, the loss of distinct articulation, the loss of expression, the loss of motion of the eye-lids, and consequent inflammation of the eye, must follow such an operation.

Much has been said in favour of experiments when made by men who are positively without any expectation of the result, or, as they affirm, are unbiassed. The only instances of this that I can allow, are when the surgeon cuts the nerves of the face in a surgical operation. In such operations as these for tic douloureux, he is indeed unbiassed; and we have seen the result, that after fifty years of such experience we remained quite ignorant of the distinctions in these nerves. But, on the other hand, when attention is roused to inquiry by anatomy, facts are obtained of the utmost importance both to the knowledge of disease and to the safe practice of surgery.

Of the Motor or Manducatory portion of the fifth nerve.

The fifth nerve is usually called Trigeminus, from piercing the skull in three grand divisions. But when it has been shown that it is composed of two distinct roots having different functions, the accidental circumstance of its divisions passing through the bones yields in importance to another inquiry, How is the muscular portion of the nerve distributed?

Since the publication of my first paper this inquiry has assumed importance; although the principal facts of the anatomy were known to Wrisberg, Santorini, Paletta, Prochaska, and Sœmmerring. But in no author is the anatomy of the motor portion of the nerve traced with sufficient minuteness, or regard to the distinct uses of the muscular and sensitive divisions.

The motor division of the fifth nerve passes under the Gasserian ganglion, and free of it. It is not seen when we look from above, as in the plates of Monro. When the nerve is turned up and dissected, this portion is seen to form about a fifth part of the whole nerve. It is tied to the larger portion before advancing to the ganglion, by filaments which have been sometimes taken for nerves.

Having passed the ganglion, it attaches itself slightly to the superior maxillary nerve, but this is apparently a membranous connexion only*. The nerve itself joins the third grand division after passing the foramen ovale. At this point the muscular and sensitive portions of the nerves are matted together, and form a mass which between the fingers feels like a knot*. There is, however, no red and fleshy-like matter interposed here, as in the Gasserian ganglion of the trunk of the nerve. But the filaments of both portions of the nerve are here so complexly and intimately combined, that all the branches which go off after this union are compound nerves, and have motor filaments in their composition.

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* Gerardi, commenting on Santorini, says that the anterior root (the motor) does give filaments to the superior maxillary division of the fifth. Prochaska (de Structura Nervorum) gives two views, tab. ii. fig. v. vi., which represent an actual

It is, however, equally obvious that the gustatory division of the nerve which descends from this mass has not the muscular portion given to it in that abundance which those branches have which take their course to the muscles of the jaws. The mandibulo-labralis, which also descends from this plexus, lies nearer the motor portion, and has a more distinct addition given to it than the gustatory nerve.

This motor or muscular portion which we are tracing sends off no branch either in its course under the great ganglion, or after passing it about half an inch. But when it has arrived at the point of union with the ganglionic portion, the filaments become interwoven; and from this place the nerves are compound, and go off diverging to their destinations. First, there are sent off nerves to the temporal, masseter, and pterygoid, muscles, also to the buccinator muscle. The temporal muscle receives a

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union of the anterior root and the superior maxillary nerve. In the plate, however, the twigs seem rather to go from the ganglionic into the motor division.

* Santorini says, it is a plexus like a ganglion, "in plexum vere ganglioformem mutatur."

large and appropriate nerve. The nerve to the masseter passes between the coronoid and condyloid processes of the lower jawbone; but before going into the muscle it sends branches to the temporal muscle. The pterygoid muscles have each their appropriate nerves coming directly from this plexus.

Ramus Buccinalis Labialis.

This is a remarkable branch, which arises from the same source, and goes to the cheek and lips. This nerve where it lies on the external pterygoid muscle sends one more branch to the temporal muscle; it then divides, one branch enters the buccinator muscle, and another is prolonged forwards. The division to the buccinator muscle is tortuous, which is no doubt a provision for its being undisturbed by the free motion of the cheek; its minute branches may be traced until lost among the muscular fibres, whilst others penetrate to the lining of the cheek. The prolonged branch is the labial division; it runs nearer the alveolar processes of the lower jaw, and becomes so superficial as to admit a union with the portio dura: from thence, passing under the facial artery, it may be traced into the triangularis or depressor anguli oris, the levator labiorum communis, and the lateral portion of the orbicularis oris.

In the distribution of the buccinalis labialis to the muscles of the mouth, it is joined, as I have said, by branches of the portio dura; and nothing is more striking than the manner in which this latter nerve passes over the masseter, a muscle of the jaw, to be profusely given to the muscles of the lips.

There is one more branch important to the physiology of the fifth nerve. At the root of the mandibulo-labralis (where it is sent off from the junction of the muscular and ganglionic portions) a small nerve takes its origin. This branch runs parallel to the greater nerve till it enters the foramen in the lower jaw; here it seems to enter, but does not; it takes a course on the inside of the jaw to arrive at its final destination, the mylo-hyoideus and the anterior belly of the digastricus, that is, to those muscles which open the mouth by drawing down the jaw.

We may for a moment interrupt our particular inquiry, to notice that all muscular nerves, and consequently the muscular divisions of the fifth nerve, form a plexus. The plexus, formed by the motor and ganglionic divisions of the fifth nerve before they diverge to the muscles of the lower jaw, corresponds with the plexus formed on the nerves sent to other classes of muscles. Even that branch of the third division of the fifth nerve which comes out before the ear joins the portio dura in a plexus*; and this is the reason of that sensibility evinced in the facial nerve in making experiments upon it.

The form of the fifth nerve, and its resemblance to the spinal nerves, had struck some of the best continental anatomists. But as they had made no distinctions in the functions of the roots of the spinal nerves, so neither did they imagine any difference in the roots of the fifth nerve, and therefore no consequence resulted from having observed this resemblance. This part of the anatomy, together with the whole minute relations of the nerves, was a dead letter, and led to no inference.

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* See the adjoined plate.

But now resuming the course I have hitherto followed, the anatomy of the fifth nerve points to curious results. We see that the motor division of this nerve goes first to the muscles which close the jaw and give it the lateral or grinding motions. Secondly, we see that it is distributed to the muscles of the cheek, which place the morsel under the operation of the teeth; and thirdly, we find it going to the muscles which open the jaws.

We proceed to the second method of proof, by experiment. Does the fifth nerve move the jaw? is it indeed the manducatory nerve as suggested by the anatomy? Let the following experiments determine the fact.

EXPERIMENT I.

The root of the fifth nerve being exposed in an ass and irritated, the jaws closed with a snap.

EXPERIMENT II.

The fifth pair being divided in an ass, the jaw fell relaxed and powerless.

If we consider the action of mastication, we shall see what the consequence would be, were there no accordance between the motions of the lower jaw and the cheeks. Conceiving that there must be such an accordance, and contemplating the roots of the fifth pair and their distinct functions, I had imagined that this office was performed by the branches of the second division of the fifth. But finding that the connexion between the motor root and the superior maxillary nerve proved to be only by cellular texture, and considering the affirmation of M. Magendie and those who followed him, that the infra-orbitary branch had no influence upon the lips, I prosecuted with more interest the Ramus Buccinalis Labialis. And nobody, I presume, will doubt that the distribution of this division confirms the notions drawn from the anatomy of the trunk,—not only that the fifth nerve is the manducatory nerve as it belongs to the muscles of the jaws, but also that it is distributed to the muscles of the cheek and lips to bring them into correspondence with the motions of the jaws. Let us take in illustration the articulation of the bones. In the joints, the muscles are attached to the capsular membrane in such a manner as to draw it from between the bones and adapt it to the degree of flexion of the joint. If the cheek were a passive membrane like the capsule of a joint, it would have required some such mechanical connexion with the jaw or its muscles, as might have drawn it from between the teeth in the motions of mastication. But being a muscular part, to bring it into just relation with the motions of the teeth, it must have an accordance through nerves, and act in sympathy;—relax when the jaws are apart, and contract when they are closed. I think therefore we may perceive why a branch of the motor nerve of the muscles of the jaws sends a division to the muscles of the cheek and to the angle of the mouth.

By such a process of reasoning we see also why a branch of the same nerve should prolong its course under the chin to the muscles which are opponents to those which close the jaw.

In short, the motor portion of the fifth nerve sends no twigs with the ophthalmic division, nor with the superior maxillary nerve, but only with the lower maxillary nerve. To the muscles of the lower jaw alone which are in action during mastication, and to the muscles necessarily associated in that action, the manducatory nerve is distributed.

It remains only that we observe what takes place in man, and compare the circumstances with experiments on brutes.

I was consulted in the case of a lady with an uncommon disease in the side of the head: the description of her condition puzzled me very much; there was so much said of tumours with pulsation on the head and face. But when I saw and examined her, the mystery disappeared; she had powerful spasms of the temporal and masseter muscles, which rose and swelled, under the excitement of a disease of the cheek, and with a pressure of the jaws so powerful as to displace the teeth. During this violent spasm of the muscles supplied by the fifth nerve, the motions of the features were free and unconstrained under the influence of the portio dura of the seventh nerve.

I have the precise counter-part to this morbid condition of the muscles of mastication in the case of a poor man now under my care. He has a disease affecting the fifth nerve of the left side, attended with the loss of sensibility of the side of the face and of the surfaces of the eye. In him there is no motion of the muscles of the jaw of the affected side. In chewing, the action is only on the right side of the head; the masseter muscle and temporal muscle of the left side do not rise or bulge out as in their natural actions; but his command over his features is perfect through the operation of the portio dura.

It appears, therefore, that the disease of the fifth nerve, which has destroyed the sensibility on one side of the face, has caused a loss of motion in the muscles of the jaw on the same side.

A more frequent occurrence establishing the distinction of motions influenced by the fifth and seventh nerves, is presented in the case of paralysis of the portio dura; for then all the muscles waste but those supplied by the fifth. In the case referred to, of the man wounded by the horn of an ox, in whom the portio dura was torn, and who had the skin of his forehead, side of the nose, cheek and lips, deprived of all fleshiness and substance, and in fact wasted to mere skin, the muscles of the jaw were entire and prominent; and on introducing the finger into the mouth and making him imitate the motions of mastication, a weak contraction could be felt in the cheek*.

These facts close the evidence of the fifth nerve being a double nerve; not only the nerve of sensibility to the head and face, but a muscular nerve to the muscles of the jaws, active in mastication, and otherwise useful in all animals whose jaws are prehensile and used as hands. This curious fact, originally drawn from the anatomy and now confirmed by it, had nearly been obscured by experiment; since the external branches of the fifth nerve, those most exposed to the experimenter, are not muscular.

I am bound to acknowledge here the correction by M. Magendie, in regard to the office of the suborbital division of this nerve, since it has given occasion to the revisal of the anatomy*.

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* How often a question has occurred as to this motion in the cheeks, may be seen on referring to cases, p. 123, Exposition, &c. and p. 57, Appendix, first edition.

We were involved in great confusion by the discovery of new branches of nerves and of ganglions, through which we had no guide, until we formed a correct arrangement of the whole system. It is satisfactory to find that the ideas first suggested by a comparison between the roots of the nerves and their complex distribution in the face and neck are correct, when tried by a minute investigation of the internal nerves of the head; and that the conclusions drawn from the anatomy are confirmed both by experiment and by a knowledge of the effects of injuries and of disease in the human frame.

Additional Note.—As the most important fact in this paper is that ascertained by experiments on the fifth nerve, I am bound to say by whom they were made, and for what purpose.

To my late brother-in-law, Mr. John Shaw, whom I educated, I have been indebted through the whole of this inquiry. He had long been acquainted in the most intimate manner with my pursuits. He had repeated my experiments on the roots of the spinal nerves, confirming the results—that the anterior roots when irritated caused the muscles to contract, and that the posterior roots had no such influence.

He assisted me in my experiments on the nerves of the face, which were for the purpose of establishing that the fifth pair resembled the nerves of the spine, and at the same time proving, what was incomplete from the experiments on the spinal nerves, that a ganglion on one of the roots of a nerve is no cause of interruption to sensation, but the sign that it bestows sensibility; making certain what could be only assumed from the experiments on the spinal nerves.

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* M. Magendie says, " Le résultat que nous avons obtenu s'accorde parfaitement avec celui que nous venons de rapporter, à l'exception toutefois de l'influence de la section de sous-orbitaire sur la mastication, influence qui n'a pas été evidente pour moi." Journal de Physiologie, 1821.

But he was acquainted also with my opinions drawn from the distribution of the nerves in the body contrasted with the anatomy of their roots. And when the correctness of these opinions was established by experiment, he let no opportunity pass of advocating and supporting them. In collecting information and making dissections he was ever active, as all the real students educated with him will testify. It was in the fervour of his zeal that he went to Paris and explained the arrangement by which I distinguished the nerves, and repeated my experiments with M. Magendie and others at Charenton near Paris in 1821.

At this time an idea was thrown out that the fifth nerve was no more than the sensitive nerve of the face accidentally separated from the muscular nerve (the portio dura). Perceiving that if this notion prevailed we should be thrown back into our former state of confusion, and to put the matter beyond all question, Mr. Shaw performed those experiments which are contained in this paper—experiments which in the gentleness of his nature he would have hesitated to make from their severity, but for their being imperatively called for.

Had Mr. Shaw lived, this subject would have been further advanced. Whilst his excellent judgment and indefatigable exertions aided me in every difficulty, his gratification in witnessing the progress of these inquiries was a reward beyond what I have now to look for.

EXPLANATION OF PLATE VII.

In this figure the superficial nerves of the face are turned off, and the distribution of the third division of the fifth to the muscles of the jaws and cheek exposed.

A. The *vortio dura* of the seventh or respiratory nerve of the face coming out from the stylomastoid foramen; the principal branches are cut and folded forwards.

B. The trunk of the *portio dura* of the seventh, dissected off the face and pinned out, while it is left at its connexions with the branches of the fifth on the cheek and lips.

C. The branch of the third division of the fifth nerve, which joins the plexus of the *portio dura* before the ear. Some experimenters, ignorant of this junction of a sensitive nerve with the muscular nerve, have occupied themselves with experiments to ascertain the degree of sensibility of the *portio dura*.

D. In this figure the masseter muscle is dissected from the jaw-bone and lifted up to show D, the branch of the fifth pair of nerves going into the muscle.

E. The Ramus Buccinalis-labialis, that branch of the fifth nerve which goes to the buccinator, triangularis, levator labiorum, and orbicularis muscles.

F. That branch of the fifth nerve which separating from the mandibulo-labralis goes to the muscles which depress the lower jaw.

G. The suborbitary nerve, a branch of the fifth nerve.

H. The mandibulo-labralis, a branch of the fifth nerve coming out from the bone to the muscles and integuments of the lip and chin.

I. A branch of the fifth nerve descending from the orbit.

D, E, F, are muscular branches of the fifth nerve, and are motor nerves. C, G, H, I, are sensitive branches of the same nerve which join the branches of the *portio dura* in its universal distribution; and although these branches of the fifth enter the muscles, they possess no power over their motions. B is the *portio dura*, which, though taking the same course with the last, is for a different purpose; while it is a motor nerve, by its association with the respiratory nerves, it is enabled to excite those actions of the face and lips which are necessarily connected with the act of breathing.

EXPLANATION OF PLATE VIII.

Fig. 1. Represents the fifth nerve dissected out and seen on its lower surface.

A. The posterior or sensitive root before it forms the ganglion.

B. The Gasserian ganglion.

C. The anterior or motor root of the nerve passing the ganglion.

D. The third or lower maxillary division of the fifth nerve.

E. The motor portion joining the lower maxillary nerve and forming a plexus with it. From this plexus go off the muscular nerves to the muscles of the jaw, viz.

1. Temporalis.
2. Massetericus.
3. Buccinalis labialis.
4. Pterygoideus.
5. Mylo-hyoideus.

F. Division which joins the *portio dura.*

G. Mandibulo-labralis.

H. Gustatory nerve.

I. The chorda tympani.

Fig. 2. This figure represents the ganglion on one of the spinal nerves, to show its resemblance to the ganglion of the fifth nerve in every particular.

A. The posterior or sensitive root of the nerve.

B. The ganglion formed upon the posterior root.

C. The anterior or motor root of the nerve; this arises in minute branches which join to form the larger subdivisions, whilst the posterior root is composed of simple and abrupt portions. This division joins the sensitive division beyond the ganglion exactly in the same manner that the motor portion of the fifth joins the lower maxillary nerve.

Fig. 3. Represents one of the ganglions of the sympathetic nerve to show how different it is from those on the symmetrical system of nerves. In fig. 1 and 2 the nerve on entering the ganglion and escaping from it, is separated into branches in a manner very different from the mode in which the sympathetic nerve joins or forms its ganglions*.

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* Authors who have treated of the anatomy of the ganglions have not distinguished between the two classes of ganglions as belonging to the sensitive and sympathetic systems of nerves.

OF THE NERVES

WHICH

ASSOCIATE THE MUSCLES OF THE CHEST, IN THE ACTIONS OF BREATHING, SPEAKING, AND EXPRESSION:

BEING

A CONTINUATION OF THE PAPER ON THE STRUCTURE AND FUNCTIONS OF THE NERVES.

From the Philosophical Transactions, 1822.

OF THE NERVES, &c.

[*Read before the Royal Society, May 2*, 1822. *With Additions**.]

The following paper contains an exposition of the nerves of respiration; their peculiarities, drawn from anatomy; their distinguishing properties, physiologically considered; and their morbid conditions. It is a subject of some difficulty, because the anatomy is intricate; and this, I suppose, is the reason why there are some who comprehend the distinctions made in the spinal nerves, and the difference in function of the nerves of the face, but do not venture to hold an opinion on this more difficult subject. I regret this; for it is here that we have the practical benefit arising from a knowledge of the different systems of nerves. It is the knowledge of the nerves of respiration distributed on the neck, throat, and thorax, that will enlighten the physician in distinguishing symptoms of disease.

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* I have added more freely to this paper than to the former. I have felt disappointment that so great a subject, so full of interest, and so useful in practice, should have made so little progress; and under the idea that there must have been something obscure in the writing, I have attempted to improve it.

OF RESPIRATION.

Of the action of the chest, neck, and face, in respiration; of the nerves which combine these parts and control their actions; and of the offices performed by these organs of respiration, in subservience to other purposes than the conversion of venous into arterial blood.

The term respiration gives rise to no other idea in the mind of the physiologist, than of certain chemical changes wrought in the lungs. What, says a very eminent philosopher, is the meaning of speaking of the respiratory nerve of the face? what has the face to do with respiration? The meaning of applying the term respiratory nerve of the face is, that such a question might be asked, and that we should be brought to consider the action of respiration in a better and truer sense, and not as limited to its influence on the blood; that we may have our minds opened to the interesting spectacle which is to be exhibited in this paper; and that we may perceive, and learn to appreciate, the marvellous combination of parts, by which we have breathing, voice, speech, and expression, besides smelling, coughing, sneezing, vomiting: in short, such a combination of actions as minister, not only to the vital act of oxygenation, but to the higher properties of mind, as well as to a number of lesser actions necessary to our very existence.

Let us suppose, that nature was as improvident as we may have conceived her to be; that the act of dilating and compressing the chest was sufficient to the act of respiration; how is the air to find admission through the long, membranous, and compressible tubes which communicate between the lungs and the atmosphere? Just as it does in an apoplectic man; the lips would move like valves flapping in the stream of air; the nostrils would be collapsed when they should be expanded; the velum pendulum palati would fall down upon the passage; the muscles of the glottis would be relaxed, and, instead of the variety of sounds and articulate language which result from the accommodation of these muscles with those of respiration, there would issue no sound but the snoring, or stertorous breathing, as in the apoplectic person.

1. Let us examine these points one by one. I have at present a patient paralytic in one side of the face; when he draws his breath this nostril is drawn together; almost shut at the instant when it should be expanded: and to breathe in excited respiration he must breathe through his mouth*.

2. If we are looking into a patient's throat, what do we say to make him draw up the palate, that we may see into the fauces? do we tell him to draw up his uvula? Even if he knows what we mean, he has no direct power over the motions of that part. We tell him to draw his breath, and in this action we see the uvula and velum retracted, and the passage widened. And so it happens that, as nature has connected the nostril with the motion of inspiration, and the orifice of the tube expands according to the necessity for inspiring air, in the same manner the fleshy curtain which hangs in the fauces is furled up during inspiration through the mouth.

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* See Case VI. in the Appendix, and page xii.

3. At the same time that these motions of the nostril and fauces take place, the chink of the glottis opens at each inspiration, as I think was first noticed by Le Gallois, and which I have also witnessed*. The glottis, pharynx, and nostrils must expand in proportion to the call for free inspirations; and without this our condition would be worse than that of the asthmatic; we should be suffocated. It will be presently shown how much further the sympathies of the act of respiration extend; but these facts sufficiently evince that there must be a wide-spreading means of connexion between parts that are remote, to provide for freedom in the simple act of breathing, independently of those accessories, or those operations performed though the apparatus of respiration for other objects than the oxygenation of the blood. We shall take an illustration from the breathing of a horse. The horse does not breathe by the mouth, but only through the nostrils; therefore are those tubes formed of large moveable cartilages, which expand under the influence of appropriate muscles. When a horse has run his stage, the motions of his flanks, his sides, his neck, and nostrils, exhibit a degree of excited action, which corresponds with the accelerated state of the circulation, and the sweat that pours down from him. This inflation of his nostril, and the outstretched position of his head, exhibit the necessity of the air tube being made free and capacious, in proportion to the

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* In a rabbit dying under the experiment of dividing the spinal marrow below the roots of the respiratory nerves, and insensible: whilst the diaphragm and muscles of the neck and of the nose moved in regular succession: I opened the larynx. At this time the glottis was supplied by the laryngeal nerve of the left side only. Having made a section of the cartilages of the larynx, I saw that at each inspiration the crico-arytenoideus and thyro-arytenoideus muscles drew aside the arytenoid cartilage, performing a motion exactly corresponding with the dilatation of the nostril; that is, expanding the glottis, to enlarge the passage for the more free inspiration.

increased quantity of air drawn in and sent forth in respiration; and the exact correspondence of the motion of the nostril with the sides shows the necessity of nervous cords of connexion between parts so nearly related in function, although so remotely situated. Accordingly, if you ask an intelligent jockey what are the points of a horse for the turf, after speaking of the strength of the loins, the height of the hind quarters, the shortness of the bones from the hock to the hoof, he will speak of the large nostril, the broad full windpipe, and the deep chest; because his experience has shown him that good lungs are accompanied with a free and capacious tube for the entrance and egress of the air in respiration. He sees, what I wish to inculcate, that the organs of respiration are not confined to the lungs, but extend to all the parts necessary to the free play of the air through the passages in excited respiration.

Before I proceed to the formal consideration of this subject, I shall refer the reader to a comparative view of these nerves. In page 25, we have traced the nervous system in the lower animals, and we have seen that the regular ganglionic system of animals of the lower class is sufficient for motion and sensibility. But that call which gives occasion to inspiration is quite unlike pain from external impression, as the act it excites is unlike voluntary motion. It is an instinctive impulse, powerful in the moment of birth as at any after period, which calls the respiratory muscles into action; and the motion it produces is of that instinctive or automatic kind, which is perfect from the beginning.

A new sense, and a new concatenation of motions, require a new nerve, a distinct centre or origin, and a new apparatus of muscles. While yet in the inferior creatures there was a system of air tubes carried through the body, there were no muscles of respiration necessary; but when a creature higher in the scale is in possession of concentrated organs of respiration, and when to move these (which are passive in themselves) there are appropriate muscles given, what will avail those muscles if there are not also new nerves appropriated to them? They must be placed under the control of a power which would have been useless in the animal which had no lungs; and there are no other means of relationship between this new power and these new muscles than by nerves.

We perceive, therefore, how it happens that in tracing animals upwards from their simplest to their more complex organization, with each new organ, and with every acquisition of new muscles, there must be additional nerves appropriated to them.

A question has been agitated:—Is the act of respiration a voluntary or involuntary action? and, strange to say, some have determined that the action which proceeds so equably during sleep, that is uninterrupted in the insensibility of apoplexy, that continues when the head of an animal is crushed, the brain deeply injured, or the head altogether removed, is an act of volition, depending upon the impression made on the sensorium. Can it be the painful duty of a physician to attend the bed of a dying person, to see, when all sensibility falls low, how powerfully the chest and shoulders rise, and the flanks are drawn, and say that this arises from a more powerful impression on the sensorium?

Nothing but a cherished hypothesis, joined to much ingenuity, could bring a person to this conclusion, against the hourly and obvious concurrence of facts. The confusion, for such I presume there is, arises from the real difficulty of accounting for the respiratory system becoming an instrument under the influence of the will. We must distinguish that state of the breathing which corresponds with the state of the pulse, that is to say, the condition of the system by which the air is drawn and the pulse beats with exact correspondence, from the effect of volition on the breathing. We have no power to disturb the established relation between the circulation and the respiration; these are conditions of the vital functions too important to be left to the influence of the mind. The power of volition over the breathing is of a different kind altogether; it is occasional or temporary, and is permitted only so far as becomes necessary to make the apparatus of respiration subservient to other offices.

We can distend the chest by an effort of the will; and we can force the air out in bellowing, but in doing so there is an obvious interference with the respiration through additional voluntary muscles. Observe in what manner we command the breathing in this interference, and we shall better comprehend the importance of the class of nerves I am to point out: it is by closing or opening the air-tubes, by playing, as it were, on the ventiges, as in fingering a wind-instrument of music.

Thus we can close the glottis by the laryngeal muscles, and suspend the breathing for a short time. If there be no effort of the will, we breathe through the mouth and the nose equally; but we can breathe without smelling, and draw the air through the mouth without drawing it through the nose, or blow with the nose without the air coming through the mouth; and all these are irregular, partial, and temporary interferences with the act of respiration. When the act of respiration, considered in its highest office as subservient to the oxygenation of the blood, is temporarily stopped, an accurate account of this interruption is kept, and we must pant and breathe hard to make up for the time lost, or the function being so far obstructed, by this interference of the will. If all these circumstances be neglected in our course of reasoning, then to be sure we say that respiration is a voluntary act, because we can blow out a candle!

Physiologists enter freely on these inquiries, if they forget the anatomy of the nervous system; but if they were discoursing over the dissection of the nerves of the neck and thorax, I apprehend there would be some embarrassment. To us, the inquiry still shapes itself thus:—What is the meaning of this extraordinary concourse of nerves to these parts?

We shall find no clue to the intricacy of the nerves of the neck and thorax, unless we carefully consider the actions of the muscles of the neck and chest.

There are two distinct conditions of the respiratory organs. *First*—That play of the chest, soft and equable, necessary to the expansion of the lungs and the inhalation of the atmosphere. *Secondly*—A condition of more powerful exertion, in which another class of muscles comes into action, and the chest rises high and the breathing is hurried.

The first of these conditions corresponds with the state of the circulation, in which the lungs act in their primary character, as the instrument of oxygenating the blood (as the term is still used). The second is a more animated condition, and has some other end in the economy: bodily exertion or passion may be the cause of excitement, or voice and speech may be the purpose of it.

For this second condition, in which a new object is to be attained, different altogether from the original office of the lungs, there are provided appropriate muscles and nerves. We must continue to call these, parts of the apparatus for breathing, because it is upon the air that they operate; but they more properly belong to the actions of speaking, smelling, and expression—of laughing, sneezing, and vomiting: actions which are either necessary to safety in the complicated organization, or by which new and essential powers of action are developed, distinct from the original office of the lungs.

All these different offices, performed by the organs superadded to the lungs, must be studied, if we hope to explain why there is so great a concourse of nerves to the neck and chest. It is even more necessary to consider the functions of the parts, with reference to the nerves of the throat, tongue, neck, and chest, than it is to study the functions performed in the face, to enable us to detect the distinct offices of the nerves there.

Of the Muscles of the Trunk, which are brought in aid of the common Respiratory Muscles.

If we look upon the frame of the body for the purpose of determining which are the muscles best calculated to assist in the motions of the chest, when there is an increased or excited action, we shall have little difficulty in distinguishing them, and we shall have as little hesitation in assigning a use to the nerves which supply these muscles exclusively.

These muscles, in effect, we see powerfully influenced in deep inspiration, however excited. They are the mastoid muscle, the trapezius, the serratus magnus, and the diaphragm. They operate in a circle, and all would be useless in the act of respiration were one to be wanting. The serratus magnus, as every student knows, expands the ribs; but this it does only when the scapula, to which it is attached, is fixed, and unless the scapula be fixed this muscle has no operation on the breathing. The trapezius fixes the scapula by drawing it backwards and upwards. These two muscles must always correspond in action, in order to expand the chest. Now let us see how the trapezius influences the operation of the sterno-cleido-mastoideus. The mastoid muscle elevates the sternum; but only when the head is fixed, which is done by the action of the trapezius on the back of the head and neck. To this train of connexions we may join the diaphragm itself, since without the action of the serratus the margins of the thorax would sink in by the action of the diaphragm, and the force of that muscle be consequently lost. Let us attend more particularly to the exterior class of muscles.

1. *Sterno-cleido-mastoideus.*—This muscle, by its attachment to the sternum or breast bone, and to the clavicle, raises or heaves the chest. The usual description of the muscle is to consider it as a muscle of the head, the lower attachments being the *origins;* but when the head is fixed it becomes a muscle to

raise the chest, and its operation is very evident in all excited states of respiration, in speaking, and still more in singing, coughing, and sneezing. But there is something necessary to the full effect of this muscle on the chest, for otherwise it will be a muscle of the head, and not of the chest. This leads us to the next muscle.

2. The *trapezius* must fix the head or pull it backwards before the *mastoideus* can act as a respiratory muscle; and how they are combined we shall presently see. The position of the head of the asthmatic, during the fit, as well as the posture of the wounded or the dying, prove the influence of the upper part of the trapezius in excited respiration: that is to say, when the shoulders are fixed, this muscle, usually described as a muscle of the superior extremity, becomes a muscle fixing the head.

The trapezius has a still more powerful and important influence in respiration when the action rises above the ordinary condition, and that is by drawing back the scapula, to give the necessary effect to the action of the serratus magnus on the ribs.

3. The *serratus magnus anticus* being extended over the whole side of the chest, and attached in all the extent from the second to the eighth rib, is very powerful in raising the ribs and holding out the margins of the chest, which would be otherwise drawn in by the diaphragm: and to this effect the intercostal muscles alone would be insufficient in the high or excited state of respiration. But it cannot exert this power

independently of the trapezius, since, without the combination explained above, its force would be exerted in its more common office of moving the scapula, and not the ribs. Unless the scapula be fixed, or pulled back by the *trapezius*, the *serratus* is not a muscle of respiration.

In this manner do these three powerful muscles hold together in their action, combining with the diaphragm to enlarge the cavity of the chest in all its diameters. These external muscles do not interfere with the gentle actions of breathing. But if the apparatus of respiration is to be employed in any excess of action, in passion, in dying, in speaking, singing, coughing, yawning, &c. these become powerful instruments. Let us observe how necessary the muscles of the neck are to respiration and circulation.

The Action of the Muscles of the Neck shown to be necessary both for Respiration and Circulation.

In the muscles of the neck, we have a subject which has been entirely overlooked. The admirable work of Albinus, and the various little works on dissection, have not left the fibre of a muscle undescribed; and this accurate anatomy has given rise to the notion, that the subject of the muscles was complete. On the contrary, Albinus, Cooper, Innes, &c., give us the mere rudiments of knowledge: from their description of the origin and insertion of insolated muscles, we understand nothing of the combined action of muscles, or their relation to important functions. In this state of ignorance of muscular action, what can we comprehend of the nerves distributed on the side of the neck? To go fully into this inquiry, we should not only have to consider the action of respiration, but the principles of hydrostatics and pneumatics, as they illustrate the effect of respiration on the circulation. We must be satisfied with remarking, that when the sterno-cleido-mastoideus muscle lifts the sternum and clavicle in inspiration, it takes off pressure from the great veins of the neck, so that the blood from the head descends freely at this time; when the thorax descends again, these veins are compressed; and in this manner does the act of respiration assist the circulation through the head.

The platysma myoides is a muscle of respiration, and acts in aid of the mastoideus; not only assisting it in all conditions of excited respiration, but acting in a more particular manner, in alternately taking off the pressure from the veins of the neck, and again compressing them, and urging the blood into the heart. In short, the muscles of the neck rise at the same time that the thorax is raised and expanded; and the alternate rising and falling of the platysma myoides and sterno-cleido-mastoideus are essential accompaniments of the high or excited act of respiration. It is strange that so important a part of the mechanism of the frame should have been neglected so long. We notice it now because it is essential to the knowledge of the nerves of the neck.

We are thus brought to comprehend the necessity of a combination being established between these muscles, forming the exterior layer on the breast, back, and neck. How interesting, then, to find that there are nerves coming from a part of the medulla oblongata (the precise part which is proved to hold a control over the actions of respiration), and that these nerves accumulated in a narrow space at their origins do, in fact, diverge and expand out on these muscles, and on these muscles only! With what interest, I say, must we perceive, that these muscles so commonly combined in action, so necessary to each other, and which are abundantly supplied with nerves of sensation and volition, have respiratory nerves in addition distributed to them!

The proofs of the existence of such a class of nerves will presently appear. But for a moment let us take it for granted, and let us ask, with what nerves these additional respiratory nerves should be joined? We have understood that these muscles, and these nerves, are bestowed for the purpose of bringing the respiratory organs in aid of ulterior objects: those objects are, amongst others, natural sounds, articulate language, and expression. Respiration, which is a function originally limited to the exposure of the circulating blood to the atmosphere, is to become employed in operations which regard the development of the powers of the mind itself. We have just examined this superadded apparatus of muscles and nerves, and we comprehend their object. Is it not, then, with the nose and lips, and fauces and larynx, that these nerves must be joined? Accordingly we find that the nerves going to the diaphragm, larynx, pharynx, lips, and face, are associated with these, and diverge from the same source.

Origins of the Respiratory Nerves.

The nerves on which the associated actions of voluntary and excited respiration depend, arise very nearly together. Their origins are not in a bundle, or fasciculus, but in a line or series, and from a distinct column of the spinal marrow. Behind the *corpus olivare*, and anterior to that process which descends from the cerebellum, called sometimes the *corpus restiforme*, a convex strip of medullary matter may be observed; and this convexity, or fasciculus, or *virga*, may be traced down the spinal marrow, between the sulci, which give rise to the anterior and posterior roots of the spinal nerves.

This portion of medullary matter is narrow above, where the *pons Varolii* overhangs it. It expands as it descends; opposite to the lower part of the *corpus olivare* it has reached its utmost convexity, after which it contracts a little, and is continued down the lateral part of the spinal marrow less distinctly pronounced.

From this tract of medullary matter on the side of the *medulla oblongata*, arise in succession, from above downwards, the *portio dura* of the seventh nerve; the *glosso-pharyngeus* nerve; the nerve of the *par vagum;* the *nervus ad par vagum accessorius;* and, as I imagine, the *phrenic*, and the *external* respiratory nerves.

A question may be here touched upon, which, however, does not affect the main reasoning. Does this column of the *medulla oblongata* continue down the whole length of the *medulla spinalis?*

It is probable that the branches of the intercostal and lumbar nerves, which influence the intercostal muscles and the muscles of the abdomen in the act of respiration, are derived from the continuation of the same cord or slip of medullary matter; and the nerves called phrenic and external respiratory, though coming out with the cervical nerves, may in all probability take their origin from the same tract or column of the spinal marrow.

Before we trace these nerves to their destinations, let us pay some attention to the part of the spinal column from which they originate.

It has been stated that I began my researches where M. le Gallois[*] left his imperfect. This is not quite correct, since my inquiries were instituted long before I was acquainted with M. le Gallois' just celebrity: but I had confirmation of my opinion by his experiments, and more confidence that I was proceeding in a proper course. M. le Gallois had said, and the observation was confirmed in the paper of Mr. Lawrence[†], that whatever part of the brain was wanting in the acephalous child, if the origin of the eighth pair was entire, the child would respire. On the other hand, my own experiments, and my experience in witnessing the effect of injuries of the spine, had taught me that the spinal marrow injured opposite to the fifth vertebra of the neck permitted the individual to breathe and live.

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[*] Nous voici donc arivé au point d'où M. Charles Bell parti, et ce point est précisément celui où mon père s' était areté en le signalant à l'attention des physiologistes. —*Eug. Le Gallois.*

[†] *Medico-Chirurgical Transactions.* See also the Appendix.

The principal seat of power which controls the actions of respiration was thus indicated to be within a very narrow compass; and the conclusion so far drawn is confirmed by abundant evidence, that if the part so indicated be crushed, respiration stops in the instant, and death ensues without even a momentary struggle.

We have arrived at that point of the inquiry, when, with some hope of a satisfactory answer, we may require an explanation of the extraordinary intricacy of the nerves of the neck, throat, and chest.

On the side of the neck we see the *portio dura* sending down a division to the exterior cervical plexus; we see joined in the same superficial distribution of nerves the second, third, and fourth cervical nerves, the roots of the phrenic, and the branches of the ninth nerve. Deeper we find the spinal accessory, the glosso-pharyngeal nerve, the laryngeal and pharyngeal divisions of the eighth and the recurrent, the trunk of the ninth, and the gustatory of the fifth. Every dissector deserving the name of student of anatomy has stood astonished and confounded at this display.

We proceed to unravel this confusion: and for this purpose we must return to the anatomy of the *medulla oblongata,* for he who holds this in his hand has the key to the nervous system.

The *nervus vagus* arises by many distinct feet from that column of nervous matter which is between the motor and sensitive columns, in a manner very different from the roots of the spinal nerves, and from a point quite distinct from the ninth or *lingualis.* Passing out by the *foramen lacerum* in the base of the cranium, it travels extensively, supplying the pharynx, larynx, and lungs, and then by the side of the œsophagus passes into the abdomen, to be given to the stomach principally, and is ultimately lost in the solar plexus.

By reference to any common book of anatomy, the phrenic nerve (4, fig. 2, plate 9), will be found to have its great root or origin from the fourth cervical nerve; and to this is joined a more slender branch from the third cervical nerve. But, besides these roots, it has connexions, which of themselves would mark the relations of the nerve: high in the neck, it is connected with the *nervus vagus* and with the *lingualis medius* or ninth, while, at the same time, a branch is given off to the muscles of the larynx. The trunk of the nerve descends into the cavity of the thorax, and gives no branches, until, arriving at the diaphragm, it sends out numerous diverging branches, which are lost in the substance of that muscle.

It has been long known that irritation of this nerve convulses the diaphragm, and that cutting it across paralyses that muscle. These facts, with the consideration of its course, prove it to be a respiratory nerve, and such has been the universal opinion.

But to what purpose should a distinct nerve be sent to the diaphragm, if the other muscles, seated externally, and which are associated in action with the diaphragm, and as important to respiration, were left without a similar tie to unite them with each other, and with the organs of the voice?

The *inferior external respiratory nerve of the thorax* (5, fig. 2, plate 9) is a counterpart of the internal or phrenic nerve. It comes out from the fourth and fifth cervical nerves, and often it is connected with the phrenic. It diverges somewhat from that nerve, because, instead of descending within the chest, it falls over the ribs, and descends in a distinct flat trunk upon the outside of the chest, to be distributed entirely to the *serratus magnus anticus*. This muscle has nerves from the spinal marrow, because it has to combine in the motions of the frame in locomotion. But the long descending nerve is a respiratory nerve; which we may know from its origin, course, and destination: in its origin and course it is like the diaphragmatic nerve; it passes across the common spinal nerves without joining them; and in its destination also it resembles the phrenic, since it is given to a muscle necessary to full inspiration.

I come now to the *spinal accessory nerve* (3, fig. 2, plate 9)*, which is more particularly an object of interest in this paper. It is called here the superior respiratory nerve of the trunk. Experiments may take a colour from the preconceived idea, but the accurate investigation of the structure will not deceive us. The author, therefore, entreats attention to the anatomy of this nerve, as leading in the most conclusive manner to a knowledge of its functions.

It arises from the cervical portion of the spinal marrow; but instead of collecting its branches to go out by the side of the vertebræ, like the internal and external respiratory nerves, it shoots upwards within the theca of the spinal marrow, enters the skull, and joins the eighth pair of nerves; from which it has its name of accessory. We see the roots of this nerve as far down as the fourth cervical nerve*. These roots arise neither from the posterior nor the anterior column of the spinal marrow, but between the posterior roots of the cervical nerves and the *ligamentum denticulatum*, and from the *column of medullary matter* above described as the respiratory column. The origins of this nerve come off in one line, and that line is in the direction of the roots of the glosso-pharyngeal and par vagum, and of that nerve which has been proved to be the respiratory nerve of the face, the *portio dura* of the seventh. In its ascent the accessory nerve is attached to the posterior root of the first cervical nerve.

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* *Nervus ad par vagum accessorius.*

The nerve having ascended through the *foramen magnum*, passes out from the skull associated with the nerves constituting the *eighth pair*, and in the same sheath with them; they all go out through the *foramen lacerum*, and by the side of the jugular vein. In this course the accessory nerve divides into two. One of these divisions joins filaments of the *par vagum*; and these again send nerves to the *glosso-pharyngeal* nerve (9, plate 2); and sometimes a branch may be seen going to the *lingualis medius* or ninth. The more external division of the accessory nerve descends behind the jugular vein, and comes forwards and perforates the mastoid muscle. In its passage through the muscle it sends off branches which course through its substance;

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* In the ass, its roots are seen to extend much lower down.

and if, as sometimes happens, though rarely, the nerve does not pass through the muscle, these branches are, notwithstanding, invariably given to it.

When the nerve has escaped from the back part of the mastoid muscle, it forms a communication with that branch of the third cervical nerve which ascends behind the muscle; and nearly at the same time it is joined by a branch from the second cervical nerve. The superior respiratory nerve now descends upon the neck, and begins to disperse its branches in regular order to the edge of the trapezius muscle (11, plate 2); four or five branches take their course to that muscle, separate into minute subdivisions, and are lost in its substance. One more considerable division, being the lowest of these, is joined by a long descending branch of the second cervical nerve. Increased by this addition, it descends under the trapezius and behind the clavicle. Following this descending branch, it will be found exclusively attached to the trapezius. Behind the scapula it is again joined by branches from the spinal nerves; and here a sort of imperfect plexus is formed, from which, divisions of the nerve, still descending, follow the lower edge of the muscle, and are finally dispersed among its fibres.

This nerve arises from the same column with the respiratory nerves; it takes a most intricate and circuitous passage to form a junction with nerves which we know belong to that class; it sends branches to join the nerves of the tongue and pharynx; it sends branches to the larynx in company with the branches of the *par vagum;* it then crosses the great nerves of the neck, passes under the spinal nerves, goes to no other muscles in its course, but lavishes all its branches on the mastoid and trapezius muscles. To an anatomist it is as plainly set forth as if it were written in our mother-tongue, this is *the superior respiratory nerve of the trunk*[*].

Comparative View of these Nerves.

If we examine the *par vagum*, the *portio dura* of the face, the *external thoracic*, the *diaphragmatic*, and the *spinal accessory* nerves, by comparative anatomy, we shall conclude that they are all respiratory nerves, by their accommodating themselves to the form and play of the organs of respiration. In fishes, the respiratory nerve[†] goes out from the back part of the *medulla oblongata*. When it escapes from the skull it becomes remarkably enlarged, and then disperses its branches to the branchiæ and the stomach. But from the same nerve go off branches to the muscles moving the gills and operculum, whilst a division of the nerve is prolonged under the lateral line of the body to the tail. It is said that this division sends off no branches, but this is not correct; it gives branches in regular succession to the muscles from the shoulder to the tail. Experiments have been made upon these nerves, but their detail would lead us too far. It is scarcely necessary to add, that there are neither phrenic nor spinal accessory, nor external thoracic nerves in fishes, the order of their muscular system not requiring them.

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[*] *Lobstein*, in a dissertation on this nerve, finding the difficulty of accounting for the *nervous fluid* coming by a double passage to the muscle, concludes, *veniet forsan tempus quo ista quæ nunc latent, dies extrahat et longioris ævi diligentia.*

[†] The nerve which by its subdivision supplies the heart, lungs, and stomach, and the muscles of the gills.

In birds, the structure of the wing, and the absence of the mastoid muscle, render the spinal accessory nerve unnecessary; it is wanting, for the reason, that in the absence of the diaphragm there is no phrenic nerve. Quadrupeds have the three respiratory nerves of the trunk; but even in them there are variations in the muscular frame, which illustrate the appropriation of the nerves. The construction of the neck of the camel is like that of birds; there is a succession of short muscles along the side of the neck, and attached to the vertebræ; but there is no long muscle, like the *sterno-cleido-mastoideus*, contributing to the motion of respiration. There is, accordingly, no spinal accessory nerve in the neck of this animal.

We have a remarkable example of the manner in which these nerves vary in their course of distribution, and yet retain their appropriate functions, in the nerves of the neck of birds. In them, the bill precludes the necessity of the portio dura going forward to the nostrils and lips; the nerve turns backwards, and is given to the neck and throat; and it is particularly worthy of remark, that the action of raising the feathers of the neck, as when the game cock is facing his opponent, is taken away by the cutting of this nerve. If we compare the anatomy of the facial respiratory nerve, in the various classes of birds, we shall find its distribution to be analogous to that of the same nerve in the different tribes of quadrupeds. In the game cock, a few branches of the nerve pass to the loose skin under the jaw, which is dilated in crowing, the greater number being distributed on the muscles of the neck, which cause the elevation of the feathers when he puts himself in an attitude for fighting. But in the duck, which, when enraged, has little or no power of expression, the same nerve is not larger than a cambric thread, and passes only to the skin under the jaw.

The Functions of these Nerves farther illustrated.

Before having recourse to experiments on brutes, we may observe what takes place in our own bodies. By placing the hand upon the neck, we may be sensible that the mastoid muscle has two motions. The lower extremity of the muscle is fixed when we move the head; but when we use the muscle in inspiration, the head, and consequently the upper extremity of the muscle, are fixed. Now, if we endeavour to raise the sternum through the operation of this muscle, we shall find that other muscles are, insensibly to us, brought into action, which have nothing to do with this raising of the sternum. For example, if we strain to raise the lower extremity of the muscle we shall unavoidably produce an action of the muscles of the nostrils; by which association of actions, we shall discover, that we are using the *mastoideus* as a respiratory muscle. If we reverse the action, and move the upper extremity of the muscle, other muscles will be drawn into co-operation, but they will be such as assist in the motion given to the head, and there will be no accompanying motion of the nostril or throat. We may vary the operation in another way. In snuffing or smelling, if we place the fingers on the portions of the mastoid muscles which are attached to the sternum, we shall find every little motion of the nostrils accompanied with corresponding actions of the sternal portions of the muscles in the neck. These facts prove that the mastoideus muscle is subject to two distinct states of association; one in which the muscles of respiration are in action, another in which the muscles moving the head are in action.

When a man suffers fracture of the spine at the sixth cervical vertebræ, and the marrow is crushed, he continues to breathe by the influence of the three nerves which arise above the injured portion. He inspires with force; but he cannot perform expiration by muscular effort, it is only by the elasticity and gravitation of the parts that the breath is propelled. He can yawn, for that is an action of drawing the breath; but he cannot sneeze, for that is an action of expelling the breath. But this is a subject so curious in itself, and which has hitherto been so little considered, that I shall reserve it for a distinct dissertation.

A man having a complete hemiplegia, the side of his face relaxed, the arm hanging down powerless, and the leg dragged in walking, we were curious to know if the influence pervaded all the nerves of the side, or only the regular or voluntary nerves. Some trouble was taken to make him heave up the shoulder of the debilitated side, but to no purpose. He could only do it by bending the spine to the other side, and as it were weighing up the paralytic shoulder. But on setting him fairly in front, and asking him to make a full inspiration, both shoulders were elevated at the same time that both the nostrils were in motion. The respiratory nerve of the face, and the superior respiratory nerve, were entire in their office; and, although the regular system of nerves refused acting, the *sterno-mastoideus* and the *trapezius* partook of their share in the act of respiration. Seeing that the mastoid muscle has two sets of nerves, that one of these is of the class of voluntary nerves, and the other of respiratory nerves, are we not borne out in concluding, that when the head is moved, being a voluntary act strictly, it is performed through the common class of voluntary nerves? that when the chest is raised, it is an act of respiration, and is effected through those nerves which control the muscles in respiration*?

This conclusion is confirmed by the following experiment. In the ass there are two muscles which take the office of the mastoid muscle; one is inserted into the jaw, which we may call *sterno-maxillaris*, and the other into the vertebræ, viz. *sterno-vertebralis*. To these the superior respiratory nerve (or spinal accessory) is distributed in its passage to the trapezius. These muscles are at the same time supplied with numerous nerves directly from the spinal marrow. If we expose the superior respiratory nerve, and then induce excited respiration, so as to bring these muscles into powerful action in combination with the other muscles of respiration, and if, while this action is performed, we divide the nerve, the motion ceases, and the muscle remains relaxed until the animal brings it into action as a voluntary muscle.

An ass being thrown, its phrenic nerves were divided, on which a remarkable heaving of the chest took place. It rose higher, and the margins of the chest were more expanded at each inspiration. There was no particular excitement of the muscles of the neck, shoulder, or throat, at this time; so that to excite the actions of these muscles it was necessary to compress the nostrils. When they began to act with more violence, keeping time with the actions of the other muscles of respiration, the superior respiratory nerve was divided; immediately the action ceased in the muscles attached to the sternum of the side where the nerve was divided, while the corresponding muscles of the other side continued their actions.

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* See the Appendix, page cxxxviii.

After dividing the spinal marrow between the vertebræ of the neck, and those of the back, respiration is continued by the diaphragm: which experiment, as it is often mentioned by physiologists, the author has not thought it necessary to repeat, but only to institute the following experiment on an ass. The phrenic nerves being first divided, and then the spinal marrow cut across at the bottom of the cervical vertebræ, respiration was stopped in the chest; but there continued a catching and strong action at regular intervals in the muscles of the nostrils, face, and side of the neck. The main part of the apparatus of respiration was stopped, but these accessory muscles remained animated, and making ineffectual endeavours to perform the respiration. When apparent death had taken place, the ass was so far re-animated by artificial breathing, that the act of respiration recommenced; these muscles on the face and neck were restored to activity, and became subject to regular and succcessive contractions, as in excited respiration, whilst the chest remained at rest. These actions continued for a short time, and then ceased; but upon artificial respiration being again produced, the same results followed. This was repeated several times, the animal remaining insensible during these experiments, and incapable of voluntary motion.

Thus it is proved, that the common muscles of respiration being cut off from the influence of respiration, and the chest and diaphragm at rest, the muscles of the face and neck remained in action, not in voluntary action, nor in convulsions of pain, but subject to the influence of respiration, and acting in regular successive impulses.

Upon stimulating the nerves after the death of this animal, it was observed, that the class of respiratory nerves retained their power of exciting their respective muscles into action, long after the other nerves had ceased to exert any power; they were evidently of that class which retain their life the longest.

I may add, that I performed these experiments long since, and I have not repeated them, resting my conviction of the accuracy of my opinion, that these are respiratory nerves, on other grounds.

I have now to make a short statement of facts. Where the phenomena have not been observed by myself, they are from the highest authorities, and the experiments were made without reference to the views now presented to the reader.

The division of the portio dura of the seventh nerve stops the motions of the nostril and of the lips, &c.

The division of the recurrent branch of the *par vagum* destroys the voice*.

The division of the laryngeal branch of the *par vagum* stops the consent of motion between the muscles of the *glottis* and the muscles of the chest*.

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* Sectis ambobus nervis recurrentibus vox perit.—*Arnemann*, *Söemmerring*, *Morgagni*.

The injury or compression of the *par vagum* produces difficulty of breathing†.

The cutting of the phrenic nerve stops the motion of the diaphragm.

The division of the spinal accessory nerve stops the respiratory motion of the mastoid and trapezius muscles.

Thus we complete the knowledge of the circle of actions which result from the respiratory nerves, and which are necessary to breathing; and we cut off the respiratory organs by the division of the irregular nerves, although we leave the regular nerves perfect. The regular nerves, those common to all animals, do not minister to these actions of respiration in the face, throat, and neck.

The *medulla oblongata* and *spinalis* are composed of columns of nervous matter, and from the different powers of the nerves, as they arise from the one or other of these columns, it is proved that they possess distinct properties. In animals that breathe by ribs and a numerous class of muscles, and which animals have a spinal marrow, we see that a column of nervous matter is embraced between the anterior and posterior *virgæ* of that body, and that this portion may be traced downwards between the roots of the spinal nerves. From the upper part of this column, where it begins in the *medulla oblongata*, the several nerves proceed which have been just described, and on the influence of which, it has been proved, the motions of respiration principally depend. It is not an extravagant conclusion to say farther, that the power of the regular series of intercostal and lumbar nerves, as far as they regulate the respiratory actions, proceeds from the connexions of the roots of these nerves with this column, which is continued downwards, and which can throughout be distinguished from the rest of the spinal marrow.

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* *Le Gallois.*

† Vinculo compressis nervis vagis oriuntur in bestiis spirandi difficultas, surditas, vomitus, corruptio ciborum in ventriculo.—*Söemmerring*, *Haller*, *Brun de Ligaturis Nervorum.*

We are now enabled to distinguish the influence of the spinal marrow, and its regular succession of nerves, from those which have been traced in these papers. The first are essential to the act of respiration; without them the others are unequal to the task. But on the other hand, although the regular succession of spinal nerves be equal to the raising and depressing the thorax, they are not equal to the full heaving of the chest in animated exertion of the voice. They are not competent to the performance of the motions of the glottis, pharynx, lips, and nostrils, which several parts are necessarily influenced in excited respiration, as well as in the acts of smelling, coughing, sneezing, and speaking: for these, the co-operation of the whole extended class of respiratory nerves is required.

Now we comprehend the difference between the effects of injuring the medulla oblongata, and cutting the *par vagum*. In bruising the first, we at once destroy the motions of the nostrils, larynx, pharynx, glottis, the neck, shoulders, and diaphragm;

who will doubt, that, if nerves going to all these parts were simultaneously divided, immediate death would result * ?

Of the Seat of that Power which controls the Respiratory Motions.

The perfect sympathy which combines the muscles in the act of respiration—muscles seated in parts of the body remote from each other—would imply some common centre from which the power emanates. If our inquiry be directed by the anatomy, we shall not be long of discovering the seat of this influence. It is not in the brain, because animals breathe when both cerebrum and cerebellum are removed. It cannot be in all the spinal marrow, because if the spinal marrow be divided three fingers' breadth from the upper part of the column, the person breathes through the nerves which arise above the division, although not at all by those which arise below. On the other hand, it is familiarly known, that if the medulla oblongata be crushed, all actions connected with breathing cease in the instant. Here, then, must be the seat of that power which controls the motions of the nostril, pharynx, fauces, larynx, diaphragm, and shoulders, by that class of nerves which we have pointed out as diverging from this point, and have called respiratory.

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* These respiratory nerves of the thorax, the diaphragmatic, the spinal accessory, and the external thoracic nerve, are all nerves of *inspiration*. The act of inspiration is provided for in a more especial manner than the act of expiration. It requires more muscular effort, and is more essential to life. Inspiration is the first act of resuscitated life, the last of exhausted nature, and for this reason the muscles of inspiration are large and powerful, and the nerves in a double order; for not only do the lateral branches of the spinal marrow influence the act of inspiration, but these additional respiratory nerves descend from the upper part of the spinal marrow to the chest, as an additional and especial provision, guarding life.

Some modern inquirers have thought to extricate themselves from the difficulties of their subject, by ingeniously arguing that respiration is a voluntary action—that is, that a painful impression attends the cessation of breathing; that the impression is conveyed to the sensorium, and from the sensorium the will acts to make us draw breath. If we say that this action goes on in sleep, so, they will tell us, an irksome posture makes us turn in bed while asleep; but I know not how they explain the respiration in apoplexy, far less how it can be supposed possible that respiration proceeds from a sensorial impression, when it is known from undoubted authority that an animal continues to breathe after both cerebrum and cerebellum have been dug out of its skull.

We, therefore, confidently return to our position, that the medulla oblongata is the seat of that power which gives motion to the parts in respiration. But, are we deceived when we draw breath under the sensation of oppression in the chest? The belief is very natural that the condition of the heart and lungs draws after it the action of the muscles in inspiration. Is this belief consistent with the following facts?—The spinal marrow is divided below the medulla oblongata; the animal continues to breathe: the two nerves of the par vagum are divided; the nostril continues to move, the animal gasps, the chink of the glottis opens and closes, the larynx is drawn down, the diaphragm acts; all these actions are simultaneous; they follow in regular succession as in common breathing, and in this condition the animal will live some time. Here there can be no communication of sensations from the heart and lungs; all the nerves are cut but those which go out from the medulla oblongata to the parts moving. The conclusion, therefore, I must presume to be, that in the lateral portion of the medulla oblongata, from which the several respiratory nerves go off, there is seated a power which, passing out through these diverging nerves, combines the remote organs.

I know not how further to avoid the conclusion that the regular succession of actions in respiration is directly consequent upon the influence of this part of the nervous system*. It is incomprehensible, certainly, but not more so than the effect of volition: whilst the brain presides over the various voluntary movements, controlling an infinite variety of combinations of muscles in the familiar actions of the body and limbs, this portion has a power of influencing certain muscles; but with this difference—that the arrangement of muscles in their action is always the same, and the action after regular periods of intermission.

It will be objected to these conclusions, that the brain has a certain influence over the action of respiration. I must confess that this subject is obscure or difficult; but even in regard to the voluntary motions of the body, they are not directly from the brain. That relation of nervous matter which makes the four quarters of an animal move in a succession suited for progression; and that combination of muscles called flexors and extensors, which is necessary to every movement of the limbs, result from an organization in the body: these relations are not established in the brain, although the brain has power over them. In the same manner those relations of muscles, which are necessary to the act of breathing, are established in the medulla oblongata, and nervous cords connected with it, although the brain receives impressions through the medulla oblongata of the condition of the respiratory organs, and the will exercises a certain control over them.

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* I may here add a conjecture on the provision for securing the circulation through a part so vital as the *medulla oblongata*. The vertebral arteries are supposed to run in the canal of the cervical vertebræ to secure the circulation in the brain, in the event of compression on the carotids; but considering the command which this part of the medullary column exercises over the respiration, and that it is more vital than the brain, may it not be a principal object of the very peculiar course of the vertebral arteries, to supply the organ of respiratory motion free from the casualties which influence the supply of blood to parts of less consequence to life?

If the nerves of a limb which is separated from the body be excited, the muscles will not all become immediately rigid; there will be *an action* of the limb—the hind leg of the horse will seem to kick. This arises from the association of the muscles in the limb through the nerves, and from their being combined in classes. So in exciting the spinal marrow in the entire animal, there is a certain combination in the movements of the four extremities. Thus the malefactor, after apparent death, under the excitement of the galvanic influence, will spring, gape, and stare. These are so many instances showing that the system of voluntary nerves in the body is arranged with a view to combinations, and the exercise of the relative classes of muscles produce action in the limbs. The excitement does not produce a tetanic and fixed condition of all the muscles equally; on the contrary, certain relations between them are preserved, and motion of the body and limbs is the effect; and these combinations in action are shown to exist even if the head be separated from the body. When we look to the action of respiration, and make similar experiments on the respiratory nerves, they will be seen to act according to their peculiar nature or endowment. As the muscles of the limb were combined in the former instance, so the muscles of respiration, however remotely situated, are now combined into one simultaneous action; and whereas in the former one motion followed each successive application of the stimulus, in the present instance the respiration being once excited continues in a regulated succession of actions, but more and more feebly, until it again stops altogether. Here, then, we perceive, first, that there is a combination between the muscles formed in the body, and independent of the brain; and, secondly, we perceive that there is a peculiarity in the nature of the power exercised upon the muscles, according as they are muscles of volition or muscles of respiration.

The muscles of volition form one system of combined parts, the muscles of respiration form another system altogether; the difference between them is, that in the latter there is a distinct source of influence, which will both preserve the muscles combined together, and cause them to act in a regular succession. There is no more difficulty, I repeat, in conceiving that the mind operates through the nervous system dedicated to respiration, than that it has a power over the infinite variety of combinations of the voluntary muscles; combinations which these experiments show are established in the frame of the body, and not in the brain.

On the Actions of Respiration in those who have suffered Fracture of the Spine at the lower Cervical Vertebræ.

When the spinal marrow is crushed at the upper part of the spine, the man dies instantly; but if the spinal marrow be crushed opposite to the lower part of the neck, although the injury be such as to deprive him of all sense and all voluntary motion of the parts below, he continues to breathe.

It has been stated by our first authorities, that a man in these circumstances breathes by his diaphragm, in consequence of the phrenic nerve, which supplies that muscle, taking its origin from the spinal marrow above the part injured. But the observations have been inaccurately made which have led to this opinion. I shall first show how untenable such a supposition is, and then detail the phenomena which attend the fracture of the spine at this part; and, finally, show that other nerves, besides the phrenic, descend from the same source to supply the exterior muscles of the chest, and that it is in a great measure through their influence that the act of respiration is continued.

The diaphragm is that muscular septum which divides the thorax and abdomen, and by the descent of which the depth of the cavities of the chest is increased in inspiration. When it has acted and descended, and the air is admitted into the lungs, that air is again expelled by the re-action of the abdominal muscles. These muscles compress the viscera, and, by pushing them up, raise the relaxed diaphragm, preparing it for another effort of inspiration. Is it not obvious, that, if the power of the diaphragm remain entire, and the power of the abdominal muscles be lost, the respiration must stop? It would be so, were it not that there are other muscles and other nerves no less important than the diaphragm and the phrenic nerves, and which physiologists have not contemplated.

In the first part of this paper it is shown that the *sterno-cleido-mastoideus*, the *trapezius*, and the *serratus magnus*, are muscles calculated, by their combined operation, to raise the chest with great force, and to perform inspiration. It is also shown that the nerves there described as the superior and the external respiratory nerves take their course exclusively to those muscles which act upon the chest, and that what the phrenic nerves are to the diaphragm, these are to the three great exterior muscles. Were it not the action of these external muscles which raise and extend the borders of the chest, the diaphragm would exhaust its effort in drawing in the ribs, and expiration would be the consequence of the action of a muscle of inspiration. Further, when it ceased to act, the ribs would exert their elasticity, and dilate the chest*. It is also shown in this paper, that as all these nerves take their origins from the same part of the spinal marrow, they are consequently in the same circumstances as to fracture of the spinal tube. When the spine is fractured at the lower cervical vertebræ, these nerves escape injury, and continue to animate the muscles exterior to the ribs, as well as the diaphragm.

The great importance of these exterior nerves and muscles to the continuance of life will be proved by the cases of fracture of the spine. I have purposely omitted all the detail of practice, and have taken the symptoms purely in a physiological view, and as if it were an experiment, instead of a most afflicting accident to a fellow creature.

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* See Appendix, Nos. LIX., LX., LXI., LXII., LXIII., LXIV., LXV., LXVI.

In these narratives we have the account of the symptoms which accompany fracture of the cervical vertebræ, and which have hitherto been negligently considered. It appeared to me very distinctly, that, in the case first described, No. LIX., the man had the power of drawing his breath by muscular exertion, and that the expulsion of the breath was not a muscular effort, but occasioned entirely by the elasticity of the ribs and the gravitation of the parts forcibly raised by the action of the muscles. This was evident in the total want of the power to exert the abdominal muscles, or to compress or depress the chest beyond what was produced by the elasticity of the ribs; in the necessity of raising the chest at the utterance of each word; in the perfect power of yawning, which is a gradual and powerful act of inspiration; in the want of the power of sneezing or blowing the nose, which is a sudden call of the muscles of expiration into action.

The strongest reason of all for maintaining this view of the use of these nerves, which I have called respiratory, is, that respiration and the activity of the muscles of the chest did actually continue after the functions of the spinal marrow were destroyed by violence done to the tube, and that there is no other explanation of the fact than this, that those nerves which take their origin from the medulla oblongata and upper part of the spinal marrow, and which descend upon the neck and chest, did continue to animate the sterno-cleido mastoideus and the trapezius, and the muscles of the throat, in the act of inspiration. We have only further to recollect, that it was not the forcible, occasional, and voluntary motions of respiration that were thus preserved, but that by the same means, viz., by the superior, the external, and the phrenic nerves, the play of the chest in respiration during sleep was continued: these are therefore respiratory nerves, for if they had been voluntary, their function would have ceased when the patient fell asleep.

In the second case, No. LX., it is clearly proved, both by the symptoms and the dissection of the bones, that the fracture must have affected the roots of the phrenic nerves; and we are at liberty to conclude, that the difference of symptoms, in comparing it with the first case, as well as the shorter period of his sufferings, were owing to this cause.

The breathing was very different, and is described by our house surgeon in a manner to produce conviction. *His breathing was like sighing;* and at each inspiration his head was drawn between his shoulders; that is to say, by the loss of the action of the diaphragm the action was thrown on the muscles exercised through the spinal accessory nerve: and this is confirmed by what is said of the want of motion in the viscera of the abdomen; for, as it was proved in the first case, at each contraction of the diaphragm the viscera of the abdomen were propelled outward.

The want or defect of action in the diaphragm, and the act of breathing being circumscribed to the muscles of the neck and shoulders, were undoubtedly the cause of the patient sinking so soon.

In the cases Nos. LXI., LXII., LXIII., LXIV., LXV., it appears, that the spinal marrow being injured so high up as to destroy the roots of all the respiratory nerves, the death was sudden, as in pithing an animal.

I must next direct the reader's attention to the very interesting case of disease of the spine, No. LXVI., in which these observations are confirmed.

When we have ascertained these facts, certain queries are naturally suggested. Why should these respiratory nerves, which descend from above upon the thorax, go only to muscles which assist in raising and expanding the chest? Why should the act of inspiration be secured by a double provision of nerves, viz., those which come out from the sides of the spine, and those which descend from the neck, when the act of expiration is provided for solely through the former?

I would offer these reasons:—

First, The act of drawing the breath is the more difficult, and requires greater force; the act of expiration is comparatively easy, being assisted by the weight of the parts incumbent on the ribs, as well as the resiliency or elasticity of the ribs themselves.

Second, The act of inspiration is the active state; the condition of expiration is a state of rest.

Third, The inspiration is necessary to life, and must be guarded with more care, and performed with more force, than the expiration. In suffocating, the agony is in elevating the chest and drawing the breath. On the approach of death the inspiration becomes more laboured, that is, the exterior muscles are in violent action; but the act of expiration is an interval of rest.

Fourth, We can blow through a membranous and soft tube, but we cannot inhale by it, for it collapses by the pressure of the atmosphere the moment the attempt is made to draw the air through it. In forcing out the breath, there is no impediment, although the tubes are soft and pliant; but in drawing in the breath, the sides of the tube must be expanded by consent of many muscles.

Fifth, These nerves, which govern the muscles of inspiration, are linked more intimately by sympathy with the state of circulation and respiration; for we see in disease, as in experiments on animals, that when the powers of life have run low, the sympathy is still exerted with such sudden catching of the muscles of inspiration, and with an effort so powerful and unexpected, as to startle, while the expiration is soft and without effort. We perceive the same sympathy causing the same sudden and powerful inspirations, and marking the presence of life, when a person is recovering from fainting, or from suspended animation, from whatever cause; as drowning, hæmorrhage, &c. The sudden inspiration is always the first of the renewed actions of life, as it is the last in exhausted nature.

This corresponds with the experiments made on animals. When the sensibility is exhausted in the common spinal nerves from the ebbing of life, the respiratory nerves on the neck and side of the chest are still capable of exciting the muscles to renewed vibrations; they are the last to die.

These considerations exhibit the importance of the act of inspiration over that of expiration, and prove the necessity for these exterior nerves of respiration.

We have seen by experiments, that the respiratory nerves are distinguished from the other nerves by retaining their power longer; that they are alive to impression, and can be made to produce convulsions in the muscles they supply, after the other nerves are dead to the application of stimuli. In disease, during the oppression of the mental faculties, and on the approach of death, we witness these nerves, and the muscles put into operation by them, continuing their functions, when in other respects the body is dead. This circumstance, so familiar to the medical observer, might have led to the conclusion to which we have arrived, more laboriously, through anatomical investigations; that there are a great many muscles extended over the body, and which perform the common offices under the will, that are occasionally drawn into combination with the muscles of respiration, and are held in relation to the vital functions by a distinct system of nerves, and that these nerves have a centre and a source of power different from that of the voluntary nerves*.

CONCLUSION.

When we survey the full extent of the respiratory system of nerves, we are prepared to comprehend its importance to the continuance of life. The infant born without a brain can breathe if the origins of these nerves be entire*. Deep wounds of the brain, though eventually fatal, are not necessarily or instantly so. The man wounded in the spine, below the origins of the nerves which we have traced, drags on existence for a few days; but a bruise on the part of the *medulla oblongata*, from which these nerves take their departure, is death in the instant; a breath is not drawn again.

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* See Appendix, Nos. LXVI., LXVII., LXXVII.

Now since we find that many respiratory nerves depart from the same centre, and go out to all the parts of the muscular frame which move in respiration, we can better comprehend how injury of the medulla oblongata suppresses at once the act of respiration in the nostrils, throat, and windpipe, as well as the action of the muscles both without and within the chest; even the expression in the agony of dying is, by the injury of the roots of all these nerves, suddenly interrupted, and actual death follows quickly, owing to the cessation of the respiratory functions.

The next thing that strikes us in the vital character of these nerves, called respiratory, is, that as they form a system belonging to the heart, lungs, stomach, larynx, throat, and the whole exterior association of muscles of respiration, and are essential to life, they must be influenced in all mortal affections; and in fact, death cannot take place whilst this division of the nervous system is unchanged or unaffected. On the contrary, the injury to their roots is attended with immediate death, and the change takes place with appalling suddenness.

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* See Appendix, No. LXVIII.

On the contrary, if other parts of the body are injured by disease or accident, death comes slowly from the rising of inflammation, or the extension of the influence gradually over the system; at length the respiratory system partakes of the influence, the chest rises higher and more frequently, an alarming symptom, when there is reason to fear approaching dissolution; the throat is then affected; the whole apparatus of respiration is violently agitated; the chest, neck, lips, cheeks, and eyelids are wrought with terrible convulsions; the breathing is about to stop; the action returns with sudden and startling effort, and then ceases, the patient dying in the state of expiration, the muscles of inspiration being incapable of renewing the effort.

If it be important to know the approach of danger, and to distinguish nervous agitation from the formidable symptoms of approaching dissolution, it is necessary to know the causes of these symptoms, otherwise the physician is no better than the nurse.

In sleep the offices of the regular nerves are resigned, but the irregular nerves remain in play; such is also the case in apoplexy, and on the approach of death. Were the same influence to spread over all the nerves on the approach of sleep, death would be the consequence. This consideration gives us interest in the statement made by a patient, No. LXXVII. of the Appendix, where we find that the pulse began to beat slow and weak, and the respiration to be interrupted at the moment of dropping asleep; the struggle of death, in fact, awoke him!

The physiological and pathological observations connected with the demonstrations of the par vagum, are among the most interesting in physiology; but they make no part of the author's particular views. Let it only be recollected that the *nervus vagus* is the nerve of the pharynx, larynx, lungs, and stomach, and that derangement in any one of these organs most singularly disorders the functions of the others. And that we are to consider the stomach to be fully as much tied to the respiratory muscles as the lungs themselves; instance the act of vomiting. The stomach, indeed, as being the part most liable to derangement from the irregularities in our mode of life, and from having reflected upon it almost every disorder to which the system is subject, is the most frequent source of nervous symptoms. Although these respiratory nerves be justly accounted the most vital and important, their more serious morbid conditions are often mimicked by symptoms which have their cause no deeper than derangement of stomach.

Men capable of investigating by a just mode of observation and of induction will, I hope, apply themselves to this class of diseases. Hitherto the disorderly demonstrations of anatomy have rendered this department of pathology far from satisfactory.

Paralytic and Convulsive Affections of the Respiratory Nerves.

As these nerves belong to a distinct system, and have a different origin from the nerves of sensibility and common muscular motion, so it is fair to presume that they will occasionally be affected by disease, when the others are left in a natural and healthy condition. But if the natural distinctions of the nerves be negligently considered, the affections of the respiratory nerves must remain obscured. The portio dura, or respiratory nerve of the face, is very subject to derangement, producing partial paralysis, or frequent and spasmodic twitchings of the face. The most common defect proceeding from this cause is a rapid and twinkling motion of the eye-lid of one side. Sometimes we find the whole of one side of the face subject to contractions, by which the features are drawn towards the ear. This condition of nerves, and consequent spasmodic muscular contractions, sometimes extend to the neck: then we see the head suddenly twitched sidewise, at the same moment that the mouth is drawn aside. This is a great deformity; for while the individual is animated, and speaking with exertion, he gives those sudden startling motions, opening his mouth and turning it to his shoulder, as if he were catching flies. The neck is twisted, the head bent down, and the mouth turned laterally and opened. These motions must now be attributed to the influence of the respiratory nerves of the face and neck.

But the same class of nerves, in their distribution to the chest, are liable to similar derangement. It is not very uncommon to find the shoulder of a young person falling low, and the appearance of distortion produced by a paralysis of that part of the trapezius muscle which supports the shoulder, and which is supplied by the spinal accessory nerve. This affection forms a parallel with the paralysis of the eye-lid and the cheek; and there are not wanting examples of spasmodic affection of the thorax resembling those which I have just noticed on the side of the face and neck. From inattention to the source and nature of the complaint, the cases in the Appendix are, perhaps, the first which are recorded*.

Now we perceive that these nerves of respiration, so peculiar in relation and function, are differently influenced by disease from the other divisions of the nervous system. We know that their functions are left entire when the voluntary nerves have ceased to act, and that they are sometimes strangely disordered, while the mind is entire in all its offices, and the voluntary operations perfect. In tetanus the voluntary nerves are under influence, and the voluntary motions locked up in convulsions; in hydrophobia, on the contrary, the respiratory system is affected; and hence the convulsions of the throat, the paroxysms of suffocation, the speechless agony, and the excess of expression in the whole frame, while the voluntary motions are free.

The frequency of sudden death, where no corresponding appearances are exhibited in the brain or heart, leads us to consider more attentively the only part of the system through which life can be directly extinguished. In *angina pectoris*, we witness the agony of suffering in this system when the patient survives; and when he dies suddenly we can imagine it to proceed from an influence extending over these nerves, and interrupting the vital operations. We have seen that a branch of this system may suddenly cease to operate on the corresponding muscles, and that in this way the side of the face may be deprived of all participation in the act of respiration, and all expression be lost. What would result from a more universal defect in the actions of this class of nerves, but sudden death?

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* See Appendix, Nos. LXXI., LXXII., LXXIII., LXXIV., LXXV., LXXVI., LXXVIII., LXXIX., LXXX., LXXXI.

The stomach, supplied with the great central nerve of this system, exhibits the most powerful influence on these extended nerves; a blow on the stomach "doubles up" the bruiser, and occasions that gasping and crowing which sufficiently indicates the course of the injury; a little more severe, and the blow is instantly fatal. A man broken on the wheel suffers dreadful blows, and his bones are broken, but life endures; the *coup de grace* is the blow on the stomach.

The position of the asthmatic shows how this system is affected; whether directly or indirectly, it is not our present business to inquire. He stands stooping forward, resting his arms so as to throw the muscles of the chest into operation upon the ribs. The position of the head and the rigidity of the muscles of the neck, the action of the mastoid muscle, and of the cutaneous muscle, visible in the retraction of the cheeks and mouth, and the inflation of the nostrils, carry us back in review of the nerves and muscles of respiration.

Some additional Notes on the Nerves of Respiration.

It will now, perhaps, be acknowledged, that the methods of physiologists, in accounting for the combination of parts in the actions of respiration, were very imperfect, or rather altogether erroneous. To account for the convulsion of the diaphragm in sneezing, they were constrained to go a far way about: first, connecting the roots of the phrenic with the sympathetic nerve; bestowing sensibility on the latter, which it does not possess; then, following a remote connexion between it and the nerves of the nose; then again, counting the relations between the facial nerve and the third of the neck: they satisfied themselves that they had explained the manner in which the diaphragm became convulsed upon irritating the membrane of the nose. Another misconception was ingrafted on the first; they spoke of these actions as convulsive and irregular, which are amongst the most admirable provisions for the protection of life. As to the act of sneezing, like coughing, it is a consequence of an irritation of the fifth pair in the membrane of the nose, whence the whole muscles of respiration are brought into action. That there is nothing accidental, nor of the nature of convulsion, is shown by the admirable adjustment of the muscles to the object. A body irritating the glottis will call into simultaneous action the muscles of respiration, so as to throw out the air with a force capable of removing the offending body. But if the irritation be on the membrane of the nose, the stream of air is directed differently, and, by the action of sneezing, the irritating particles are removed from these surfaces. By the consideration of how many little muscles require adjustment to produce this change in the direction of the stream of air, we may know, that the action is instinctive, ordered with the utmost accuracy, and very different from convulsion.

Of Smelling, as influenced by the Portio Dura of the Seventh Nerve.

In these papers I hope it will be found that I have gone deliberately and diligently about my investigation. It will, I hope, be acknowledged that I have studied the functions of the parts to which the nerves are sent, before I made my experiments or drew my conclusions. Even in the exercise of the sense of smelling, parts are employed which do not, at first, seem necessary. For the highest enjoyment or exercise of the sense of smelling, the stream of air must be inhaled through the nostrils, changed in its direction and increased in force. In breathing through the nose, the air is carried directly backward. If the nostrils are expanded in anxious or hurried respiration, the passage is enlarged, and made more direct. But, perhaps, the reader is not aware that in each nostril there are two circular openings, the innermost something more than half an inch within the other. This interior circle expands, and becomes lower when the breath is forcibly drawn into the lungs; but in the act of smelling it is much diminished and elevated. The change in the form and relation of the exterior and internal nostril is produced by the action of the muscles on the cartilages; and the effect of the change is to increase the force of the stream of air, and to direct it up towards the seat of the sense of smelling. In common breathing some part of the effluvia afloat in the atmosphere reaches the seat of the sense; but fully to exercise the sense it is necessary to concentrate and direct the stream of air, as I have described.

It will now be comprehended how the destruction of the *portio dura*, or respiratory nerve of the face, affects the organ of smelling; for if by the injury of that nerve the motion of the muscles of the nostrils be lost, the breath may be drawn into the lungs through the relaxed passage; but it will not be drawn forcibly up towards the seat of the olfactory nerve, nor will the air brush over the surface on which the proper nerve of sense is expanded.

A man being paralytic on one side of the face by the loss of power in the *portio dura*, he was made to smell ammonia: it did not affect the paralytic side, because it was forcibly inhaled into the cells of the nose only on the side where the nostril was moveable. On trying the experiment on a dog, in which the *portio dura* of one side had been cut, the same thing was manifested; he snuffed it up with the sound side, and showed the natural consequence of the irritation of the membrane; while he was not similarly affected when the bottle was put to the paralytic nostril. This fact is further illustrated in cases in the Appendix*.

Unless I had attended to the structure and function of the part, on witnessing these phenomena, I might have conceived that the seventh nerve was the nerve of smelling, like a noted French physiologist, who concluded too hastily that he had discovered the nerves of vision and of smelling in the fifth nerve.

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* See page xii.

I allude to certain experiments lately performed in London by a distinguished visiter, which afford a proof of the utter impossibility of reasoning correctly on these subjects without the knowledge of the anatomy. The olfactory nerve was destroyed, and ammonia put to the nostrils of the animal, and when the creature sneezed it was a *coup de theâtre!* Then the gentlemen congratulated themselves that it was discovered that the first pair of nerves was of no use!

The sensibility of the schneiderian membrane results from the fifth nerve: it was this common sensibility which was here excited by the ammonia. Now we ask, why does the membrane possess this sensibility, and why is the sensibility joined to the actions of the respiratory system? Because these passages must be guarded as the larynx is guarded. When any thing offensive is lodged there, it must be removed, and the means nature employs is to drive the air by an instinctive action of the respiratory organs, violently and suddenly, through the nostrils. But what has this to do with smelling? As well might we destroy the olfactory nerve, and wonder that the creature experimented on still coughed when the larynx was tickled.

We have some observations on this subject in Mr. Shaw's paper already quoted. "The effect upon the nostril is the most obvious symptom, when the nerve is cut in the ass. If after having cut the right nerve *(portio dura)*, we hold the nostril for a short time, so as to prevent the animal from breathing, he will, when freed, begin to snort, but with the left nostril only. If we hold carbonate of ammonia to the paralysed nostril, he will not be affected; but if it be held to the other, he will snuff it up, and then curl the nostril, and have an expression in the whole of that side of the face, as if he were going to sneeze, while the right side will remain quite unmoved."

The rationale of this is worth attention; by the neglect of it some physiologists and experimenters have appeared to much disadvantage. We repeat that the act of smelling is not simply the act of drawing the breath; but while the breath is drawn there is a conformity in the motion of the nostrils, by which the air, loaded with the effluvia, is directed to the seat of the olfactory nerve; that is to say, is made to circulate in the higher parts of the cavities of the nose, instead of streaming directly backwards into the posterior nostrils. This was the reason why, on putting the ammonia to the nostril which was still, the creature was not excited, although there had been nothing done to injure the sensibility of that side of the nose. If a man were simply to draw his breath in taking snuff, the powder would be drawn into his fauces and lungs; but to snuff, the point of the nose is drawn down, and the nostrils contracted, and then, when the air is inhaled, the snuff rises to the superior cells, and stimulates all the interior of the nostrils*. Although by this stimulus he sneezes, the olfactory nerve has nothing to do with it. The luxury is in the stimulus of the respiratory system through the excitement of the membrane, not in the odour as enjoyed by the olfactory nerve. The sensitive branches of the fifth are first excited, then the respiratory system is in a secondary manner affected; and to ascertain whether the mode of communication between the fifth and the respiratory nerves be affected at their roots in the brain, or at their extremities, is a fair question to be determined by experiment or reasoning.

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* See Appendix, No. III., page xii. Nos. LV., LVI., page cxii.

These Respiratory Nerves are Organs of Expression.

We may notice another office of these respiratory nerves; in smiling, laughing, and weeping, the influence is solely propagated through them. The face, we have seen, is dead to all changes of the kind when the nerve of this class which goes to it is destroyed, whether it be by division of the nerve, or from its being surrounded with inflammation or suppuration. When we consider that all the respiratory nerves depart from the same source, and participate in the same functions, and more especially when we see the respiratory organs so very distinctly affected in the conditions of the mind, which give rise to these affections, it is not too much to suppose, that what is proved in regard to one of these nerves is true of the whole class, and that they alone are influenced in laughter. Physiologists who have not investigated the cause, are yet agreed in describing laughter to be a condition of the respiratory muscles, where the air is drawn in rapidly, and thrown out in short spasmodic motions of these muscles, and crying to be nearly the reverse, the inspiration being cut by spasmodic actions of the muscles of inspiration. By these considerations are explained the *subrisus* which proceeds from abdominal irritation, and the sardonic retraction of the muscles of the face produced by wounds of vital parts, and particularly of the diaphragm. They explain also the successive convulsive heaving of the shoulders in wounds of the diaphragm.

That a system of nerves, so intimately combined as this is with the other parts of the general system, should suffer in hysterical disorders, cannot surprise us; and admitting that the irritation reaches to the respiratory system, we perceive how rapidly the change may be produced, from the convulsions of laughter to those of crying; and that in these affections, if there be a corresponding condition of the mind, it rather follows than precedes the expression of the frame.

It would have been extraordinary if we had arrived at any satisfactory theory of expression, before it was known through what instruments the mind influenced the body during emotion or passion. But since we know that the division of the respiratory nerve of the face deprives an animal of all expression, and that the expressive smile of the human face is lost by an injury of this nerve; since it is equally apparent, that the convulsions of laughter arise from an influence extended over this class of nerves; it comes to be in some sort a duty, in pursuing this matter, to examine farther into the subject of expression. We may be at the same time assured that whatever serves to explain the constant and natural operations of the frame will also exhibit the symptoms of disease with more precision.

In terror, we can readily conceive why a man stands with eyes intently fixed on the object of his fears, the eyebrows elevated, and the eyeballs largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this we only perceive the intent application of his mind to the objects of his apprehension, and its direct influence on the outward organs. But when we observe him farther, there is a spasm on his breast: he cannot breathe freely: the chest remains elevated, and his respiration is short and rapid: there is a gasping and convulsive motion of his lips: a tremor on his hollow cheeks: a gulping and catching of his throat: his heart knocks at his ribs, while yet there is no force in the circulation, the lips and cheeks being ashy pale.

It is obvious that there is here a reflected influence in operation. The language and sentiments of every people have pointed to the heart as the seat of passion, and every individual must have felt its truth. For though the heart be not in the proper sense the seat of passion, it is influenced by the conditions of the mind, and from thence its influence is extended through the respiratory organs, so as to mount to the throat, lips, and cheeks, and account for every movement in passion, which is not explained by the direct influence of the mind upon the features.

So we shall find, if we attend to the expression of grief, that the same phenomena are presented; and we may catalogue them, as it were, anatomically. Imagine the overwhelming influence of grief—the object in the mind has absorbed the powers of the frame; the body is no more regarded, the spirits have left it; it reclines, and the limbs gravitate, the whole frame is nerveless and relaxed, and the person scarcely breathes: so far there is no difficulty in comprehending the effect in the cause. But why, at intervals, is there a long drawn sigh; why are the neck and throat convulsed, and whence the quivering and swelling of the lip; why the deadly paleness, and the surface earthy cold; or why does convulsion spread over the frame like a paroxysm of suffocation?

To those I address, it is unnecessary to go farther, than to indicate that the nerves treated of in these papers are the instruments of expression, from the smile upon the infant's cheek, to the last agony of life. It is when the strong man is subdued by this mysterious influence of soul on body, and when the passions may be truly said to tear the breast, that we have the most afflicting picture of human frailty, and the most unequivocal proof, that it is the order of functions which we have been considering that is then affected. In the first struggles of the infant to draw breath, in the man recovering from a state of suffocation, and in the agony of passion, when the breast labours from the influence at the heart, the same system of parts is affected, the same nerves, the same muscles, and the symptoms or characters have a strict resemblance.

Having examined the system of nerves and muscles, which are the agents in respiration, in their fullest extent and in all their bearings; having looked at them in their highest state of complication in the human body; and having traced them upwards, from the animals of simple structure, and then by experiment, and in a manner analytically as well as synthetically, their relations become obvious. Instead of one respiratory nerve, the *par vagum*, the nerve so called, is found to be the central one of a system of nerves of great extent. Instead of the relations of the vital organs of circulation and respiration depending on some supposed influence of the sympathetic nerve, they are found to have an appropriate system.

This system of nerves, extricated from the seeming confusion in which it lay hitherto encumbered, is found to be superadded to that of mere feeling and agency, attributes common to all animals. Through it we see, ingrafted as it were, and superadded to the original nature, higher powers of agency, corresponding to our condition of mental superiority: these are not the organs of breathing merely, but of natural and articulate language also, and adapted to the expression of sentiment, in the workings of the countenance and of the breast, that is, by signs, as well as by words. So that the breast becomes the organ of the passions, and bears the same relation to the development of sentiments, that the organs of the senses do to the ideas of sense.

EXPLANATION OF PLATE IX.

FIG. 1. REPRESENTS THE MEDULLA SPINALIS.

A. The *pons Varolii.*

B. B. The anterior medullary columns of the spinal marrow, continued from the *corpora pyramidalia.*

C. *Corpus olivare.*

D. *Corpus restiforme.*

1. The origin of the respiratory nerve of the face.

2. Origin of the glosso-pharyngeal nerve.

3. Origin of the par vagum.

4. Origin of the spinal accessory nerve, or superior respiratory nerve of the trunk.

FIG. 2. PLAN OF THE RESPIRATORY NERVES IN THEIR COURSE THROUGH THE BODY.

A. *The sterno-cleido mastoideus muscle.*

B. B. The *trapezius* muscle. It is seen to arise from the back of the head, and from the spine; it is inserted into

C. The scapula, and

D. The clavicle.

E. E. The *serratus magnus anticus.* It is left at its attachment to the ribs, but cut off from its insertion into the scapula, so as to expose the trapezius and the spinal accessory nerve.

F. The lower surface of the diaphragm.

G. The upper surface of the diaphragm.

H. The larynx.

The four great muscles (A. B. B. E. E. F. G.) are powerful muscles of inspiration.

To simplify this view, the regular or symmetrical system of nerves is not presented in this drawing, but only the respiratory nerves. It is the entwining of nerves of distinct systems which produces the apparent intricacy. If the spinal nerves were represented crossing these, and the network of the sympathetic superadded to them, we should have all the seeming confusion of the dissected body.

1. Respiratory nerve of the face, or portio dura of authors.

2. The glosso-pharyngeal nerve.

3. The superior respiratory nerve. It is seen to pass through the sterno-cleido mastoideus muscle, and to supply it with branches: then to take a course down the side of the neck, branching exclusively to the trapezius muscle.

4. The phrenic or diaphragmatic nerve. It is seen coming out from the spine, and running a direct course to the diaphragm.

5. The external respiratory nerve of the chest. It is like the last nerve in its origin, but it deviates in its course, passes on the outside of the chest to supply the powerful respiratory muscle, the serratus magnus E. E.

These three nerves with the par vagum combine the sterno-cleido mastoideus, the trapezius, the serratus magnus, and the diaphragm, with the lungs, the larynx, the tongue, and nostrils.

6, 7. The nerve of the par vagum. Coming from the same origin with the other respiratory nerves, it passes down to the internal organs; but in its passage gives off these:

8. The superior laryngeal nerve, a branch of the last nerve.

9. The recurrent nerve; a branch also of the par vagum. Where the par vagum is in the thorax (7) at the same time that it sends off the recurrent (9), it sends off many small nerves to the heart and the lungs, and then descends in a plexus on the œsophagus, to the stomach.

ON THE MOTIONS OF THE EYE,

IN ILLUSTRATION OF

THE USES OF THE MUSCLES AND NERVES OF THE ORBIT.

From the Philosophical Transactions, 1823.

ON THE MOTIONS OF THE EYE, &c.

[*Read before the Royal Society, March* 20, 1823.]

The object of this paper is to explain the reason of there being six nerves distributed to the eye, and consequently crowded into the narrow space of the orbit.

But before it is possible to assign the uses of these nerves, we must examine the motions of the eye more minutely than has hitherto been done, and try to comprehend the offices to be performed. Much as the eye has been studied, the frame-work which suspends it, and by which it is moved and protected, has not received the attention it deserves. Yet this frame-work, or apparatus, is not less calculated to renew our wonder, than the properties of the organ itself.

It is, therefore, necessary to divide the paper into two parts. *First,* to show the uses of the apparatus which is exterior to the eye-ball; and then, in the *second place,* to consider how the nerves minister to these offices.

PART I.

Of the Muscles and Frame-work which are around the Eye-ball.

Even grave and learned men have eulogized this organ as the most necessary to intellectual enjoyment, and which ranges from the observation of the fixed stars, to that of the expression in the human face*. But this admiration is in part misplaced, if given to the optic nerve and ball of the eye exclusively; since these high endowments belong to the exercise of the whole eye, to its exterior apparatus as much as to that nerve which is sensible to the impressions of light. It is to the muscular apparatus, and to the conclusions we are enabled to draw from the consciousness of muscular effort, that we owe that geometrical sense, by which we become acquainted with the form, and magnitude, and distance of objects. We might as well expect to understand the uses of a theodolite, or any complicated instrument for observations, by estimating the optical powers of the glasses, without considering the quadrant, level, or plumb-line, as expect to learn the whole powers of the eye by confining our study to the naked ball. I propose to show, that we must distinguish the motions of the eye, according to their objects or uses, whether for the direct purpose of vision, or for the preservation of the organ. I shall show that the eye undergoes a revolving motion not hitherto noticed; that it is subject to two distinct states, of rest, and of activity; and that the different conditions of the retina are accompanied by appropriate conditions of the surrounding muscles; that these muscles are to be distinguished into two natural classes; and that in sleep, faintness, and insensibility, the eye-ball is given up to the one, and that in watchfulness, and the full exercise of the organ, it is given up to the influence of the other class of muscles: and finally, that the consideration of these natural conditions of the eye explains its changes as symptomatic of disease, or as expressive of passion.

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* Sir Henry Wotton, Dr. Reid, and many others.

Motions of the Eye-ball and Eye-lids.

We shall consider the muscles of the eye, first, as necessary to its preservation; secondly, as necessary to it as the organ of sense. We do not reflect on those actions of our frame which are most admirable in themselves, which minister continually to our necessities, and perfect the exercise of our organs, until we be deprived of them: like unnatural children, unconscious or unmindful of indulgence, we feel only the loss of benefits. "With much compassion," says the religious philosopher, "as well as astonishment at the goodness of our loving Creator, have I considered the sad state of a certain gentleman, who, as to the rest, was in pretty good health, but only wanted the use of these two little muscles that serve to lift up the eye-lids, and so had almost lost the use of his sight, being forced, as long as this defect lasted, to shove up his eye-lids with his own hands*?" I have often thought of this saying when I have seen a patient in all respects in health, but without the power of raising the eye-lids.

There is a motion of the eye-ball, which, from its rapidity, has escaped observation. At the instant in which the eye-lids are closed, the eye-ball makes a movement which raises the cornea under the upper eye-lid.

If we fix one eye upon an object, and close the other with the finger in such a manner as to feel the convexity of the cornea through the eye-lid, when we shut the eye that is open, we shall feel that the cornea of the other eye is instantly elevated; and that it thus rises and falls in sympathy with the eye that is closed and opened. This change of the position of the eye-ball takes place during the most rapid winking motions of the eye-lids. When a dog was deprived of the power of closing the eye-lids of one eye by the division of the nerve of the eye-lids, the eye did not cease to turn up when he was threatened, and when he winked with the eye-lids of the other side†.

Nearly the same thing I observed in a girl whose eye-lids were attached to the surrounding skin, owing to a burn; for the fore part of the eye-ball being completely uncovered, when she would have winked, instead of the eye-lids descending, the eye-balls were turned up, and the cornea was moistened by coming into contact with the mouths of the lacrymal ducts.

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* Paley's Natural Theology.

† The experiment of cutting the facial respiratory nerve was performed on a dog. The following is the note made a few days after the nerve was cut:—The dog is now quite well, having suffered very little from the operation; when he fawns, the right side of his face is completely motionless; (the nerve of the right side was cut). When I threatened to strike him, although there is a tremulous motion expressive of

Instead of enforcing this fact, I shall merely refer to the numerous cases in the Appendix in which this motion is proved to take place. I ought not, however, to omit stating, that the fact has been denied, and in very extraordinary terms.

The purpose of this rapid insensible motion of the eye-ball will be understood on observing the form of the eye-lids and the place of the lacrymal gland. The margins of the eye-lids are flat, and when they meet, they touch only at their outer edges, so that when closed there is a gutter left between them and the cornea. If the eye-balls were to remain without motion, the margins of the eye-lids would meet in such a manner on the surface of the cornea, that a certain portion would be left untouched, and the eye would have no power of clearing off what obscured the vision, at that principal part of the lucid cornea which is in the very axis of the eye; and if the tears flowed, they would be left accumulated on the centre of the cornea, and winking, instead of clearing the eye, would suffuse it. To avoid these effects, and to sweep and clear the surface of the cornea, at the same time that the eye-lids are closed, the eye-ball revolves, and the cornea is rapidly elevated under the eye-lid.

fear in all the muscles of the left side of the face, the other is perfectly still: he cannot even close the eye-lid; and instead of winking when he expects to be struck, the eye-ball itself is turned up. When he is excited, there is an expression of alacrity in all the muscles of the left side of the face, and a brilliancy in the left eye, while the right is perfectly inanimate. This is shown in an extraordinary degree when he is fighting with another dog.

Another effect of this motion of the eye-ball is to procure the discharge from the lacrymal ducts; for by the simultaneous ascent of the cornea, and the descent of the upper eye-lid, the membrane on which the ducts open is stretched, and the effect is like the elongation of the nipple, facilitating the discharge of secretion.

By the double motion, the descent of the eye-lid and the ascent of the cornea at the same time, the rapidity with which the eye escapes from injury is increased. Even creatures which have imperfect eye-lids, as fishes, by possessing this rapid revolving motion of the eye, are enabled to avoid injury and clear off impurities.

I may observe in passing, that there is a provision for the preservation of the eye, in the manner in which the eye-lids close, which has not been noticed. While the upper eye-lid falls, the lower eye-lid is moved towards the nose. This is a part of that curious provision for collecting offensive particles towards the inner corner of the eye. If the edges of the eye-lids be marked with black spots, it will be seen that when the eye-lids are opened and closed, the spot on the upper eye-lid will descend and rise perpendicularly, while the spot on the lower eye-lid will play horizontally like a shuttle.

To comprehend certain actions of the muscles of the eye, we must remember that the caruncle and membrane called *semilunaris*, seated in the inner corner of the eye, are for ridding the eye of extraneous matter, and are, in fact, for the same purpose with that apparatus which is more perfect and appropriate in quadrupeds, called the haw.

The course of our inquiry makes some observation of these parts necessary.

In quadrupeds there is a gland for secreting a glutinous and adhesive fluid, which is seated on that side of the orbit next the nose; it is quite distinct from the lacrymal gland; it is squeezed by an apparatus of muscles, and the fluid exudes upon the surface of the third eye-lid. This third eye-lid is a very peculiar part of the apparatus of preservation. It is a thin cartilage, the posterior part of which is attached to an elastic body. This body is lodged in a division or depression of the orbit on the side towards the nose. When the eye is excited, the eye-ball is made to press on the elastic body, and to force it out of its recess or socket; the consequence of which is the protrusion of the cartilaginous third eye-lid, or *haw*, as it is termed, in the horse. By this mechanism the third eye-lid is made to sweep rapidly over the surface of the cornea, and by means of the glutinous fluid with which its surface is bedewed, it attaches and clears away offensive particles.

In birds, the eye is an exquisitely fine organ, and still more curiously, and as we might be tempted to say, artificially protected. The third eye-lid is more perfect; it is membranous and broad, and is drawn over the surface of the eye by means of two muscles which are attached to the back part of the eye-ball, and by a long round tendon, that makes a course of nearly three parts of the circumference of the ball. The lacrymal gland is small, and seated low, but the mucous gland is of great size, and seated in a cavity deep and large, on the inside of the orbit. As the third eye-lid is moved by an apparatus which cannot squeeze the mucous gland at the same time that the eye-lid is moved, as in quadrupeds, the oblique muscles are particularly provided to draw the eye-ball against the gland, and to force out the mucus on the surface of the third eye-lid. It flows very copiously; and this is probably the reason of the smallness of the proper lacrymal gland which lies on the opposite side of the orbit.

We already see two objects attained through the motion of the eye-lids and eye-ball; the moistening of the eye with the clear fluid of the lacrymal gland, and the extraction, or rather the protrusion, of offensive particles.

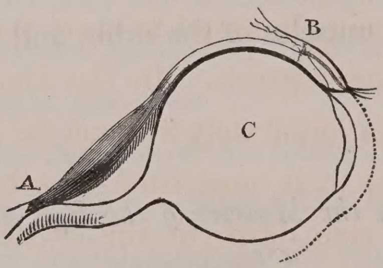
There is another division of this subject no less curious: the different conditions of the eye during the waking and sleeping state remain to be considered. If we approach a person in disturbed sleep when the eye-lids are a little apart, we shall not see the pupil nor the dark part of the eye, as we should were he awake, for the cornea is turned upwards under the upper eye-lid. If a person be fainting, as insensibility comes over him the eyes cease to have speculation; that is, they want direction, and are vacant, and presently the white part of the eye is disclosed by the revolving of the eye-ball upwards. Look to a blind beggar; these white balls are not turned up in the fervor of prayer or entreaty; it is the natural state of the eye-balls, which are totally blind, and from the exercise of which the individual has withdrawn his attention. So it is on the approach of death; for, although the eye-lids be open, the pupils are in part hid, being turned up with a seeming agony, which however is the mark of increasing insensibility. These motions of the eye, which are for the preservation of the organ, do not interfere with the vision, they are performed unconsciously. The motions of the eye-ball for directing the eye to objects are strictly voluntary, and are always connected with the exercise of the sense of vision.

It will now be admitted that the variety of motions given to the eye and eye-lids require the complication of muscles which we find in the orbit; and it must be obvious to the most casual observer, that unless these various offices and different conditions of the eye be considered, it will be in vain to attempt an accurate classification of the muscles of the orbit, and consequently of the nerves.

Of the Actions of the Muscles of the Eye, and their natural Classification.

Muscles of the Eye-lid. Even in the action of these muscles, although the most exposed and familiar of any, there is something still to be observed. The eye-ball is held betwixt the levator palpebra and the orbicularis, the one tending to the protrusion of the eye-ball, the other to compress and restrain it. In page xxxvi of the Appendix, we may observe the effect of the paralysis of the orbicularis, that the eye-ball is protruded, and starts further forward than natural, and that then the eye-lid is loose or flabby, and can be lifted like a bit of common skin.

In other cases of the Appendix it is shown, that the upper eye-lid is raised, and the lower eye-lid depressed, by one muscle. Anatomists have sought for a depressor of the inferior eye-lid, seeing that it is depressed, but such a muscle has no existence, and is quite unnecessary. The *M. elevator palpebræ superioris* opens wide the eye-lids, depressing the lower eye-lid at the same time that it elevates the upper one. If we put the finger upon the lower eye-lid so as to feel the eye-ball when the eye is shut, and then open the eye, we shall feel that during this action the eye-ball is pushed outwards. Now the lower eye-lid is so adapted as to slip off the convex surface of the ball in this action, and to be depressed whilst the upper eye-lid is elevated.



The origin of the levator being at A., and the insertion into the cartilage of the upper eye-lid at B., the effect of the action of the muscle must be the protrusion of the eye-ball, C., into the dotted line. By the elevation of the upper eye-lid, the eye starts forward a little, and the lower eye-lid slips off the lower segment of the eye-ball. This action of the muscles is happily illustrated by the case in the Appendix, No. XXI. It is curious to observe how the eye-ball retreats in its condition of repose, and is protruded when about to be exercised in vision. The high excitement, as in terror, when the eye-balls are largely unclosed, is attended with an increase of the sphere of vision by the protrusion of the eye-balls, a change remarkable both in the ferocious and timid animals, especially in the latter.

The muscles attached to the eye-ball are in two classes, the recti and obliqui. The recti muscles are four in number, and come from the bottom of the orbit, and run a straight course forwards and outwards; they embrace the eye-ball, and are inserted at four cardinal points into it. The obliqui are two muscles having a direction backwards and outwards; they embrace the eye-ball, one passing over it obliquely, the other under it obliquely.

That the recti muscles perform the office of directing the axis of the eye, turning it round to every point in the sphere of vision, there are many proofs. In the first place, their origin, course, and insertion, accurately fit them for this office; and they are obviously equal to it, unassisted by other muscles. In the next place, from man down to the cuttle-fish, the voluntary motions of the eyes are the same, and the origin, course, and insertion of these muscles are similar, while the other muscles vary with the change of apparatus which is around the eye.

The oblique muscles of the eye stand contrasted with the recti in every respect, in number, size, and direction. Yet it is a received opinion, that they antagonize the recti, and keep the eye suspended. To this conclusion there are many objections. 1. In creatures where the eye is socketed on a cup of cartilage and cannot retract, the oblique muscles are nevertheless present. 2. Where a powerful retractor muscle is bestowed in addition to the recti muscles to pull the eye-ball back, the oblique muscles have no additional magnitude given to them to pull the eye-ball forwards. 3. In matter of fact, the human eye cannot be retracted by the united action of the recti as we see quadrupeds draw in their eyes, for the exertion which we give the recti pervades the levator palpebræ also, and its action, as we have just shown, is to protrude the eye, which is an argument against these muscles being retractors, and therefore against the obliqui being their opponents, to draw it forward.

As we have just observed, the eye-ball is suspended between the muscles within the orbit, and the orbicularis palpebrarum anteriorly; this is shown by the effect of the paralysis of the orbicularis, for then the eye-ball is unnaturally protruded (see the case in the Appendix, No. X.)

To these, other objections, no less strong, may be added. We have just found that certain very rapid motions are to be performed by the eye-ball; now it can be demonstrated, that a body will be moved in less time by a muscle which is oblique to the line of motion, than if it lay in the line on which the body moves. If the oblique muscles were either opponents or coadjutors of the recti, there appears no reason why they should be oblique, but the contrary; for as the points of their insertion must move more rapidly than those of the recti, they are unsuitable. On the other hand, that there may be no difference in the time of the action and relaxation of the several classes, we see a reason why one rectus should be opposed by another, and why there being occasion for one oblique, its antagonist should also be oblique.

In proportion as a muscle gains velocity by its obliquity, it loses power; from the obliquity, therefore, of these muscles believed to be opposed to the recti, and from there being two of them to four of the latter, they are disproportioned in strength, and the disproportion proves that the two classes of muscles are not antagonists.

By dissection and experiment it can be proved, that the oblique muscles are antagonists to each, and that they roll the eye in opposite directions, the superior oblique directing the pupil downwards and outwards, and the inferior oblique directing it upwards and inwards. But it is proved that any two of the recti muscles are equal to the direction of the pupil in the diagonal between them, and there is no reason why an additional muscle should be given, to direct the pupil upwards and inwards more than upwards and outwards, or downwards and inwards. It is evident, then, that the oblique muscles are not for assisting the recti in directing the eye to objects, or there would have been four of them, but that they must have some other appropriate office. If we proceed farther, it must be by experiment.

Experimental Inquiry into the Action of these Muscles.

I. I divided the *superior rectus* or *attollens* in a rabbit, and felt something like disappointment on observing the eye remain stationary. Shortly afterwards, on looking to the animal while it was feeding, I saw the pupil depressed, and that the animal had no power of raising it.

The explanation I conceive to be this: during the experiment the eye was spasmodically fixed by the general action of the muscles, and particularly by the powerful retractor, a muscle peculiar to quadrupeds. But on the spasm relaxing, and when the eye was restored to the influence of the voluntary muscles, the recti, the voluntary power of raising the eye being lost by the division of the superior muscle, the eye was permanently depressed.

II. On opening the eye-lids and irritating the eye of the rabbit, in which the superior rectus muscle had been divided, the eye was turned up; so that though the voluntary motion was lost by the division of the rectus, the involuntary motion remained by the influence of the obliquus.

III. Wishing to ascertain if the oblique muscles contract to force the eye-ball laterally towards the nose, I put a fine thread round the tendon of the superior oblique muscle of a rabbit, and appended a glass bead to it of a weight to draw out the tendon a little. On touching the eye with a feather, I had the pleasure of seeing the bead drawn up. And on repeating the experiment, the thread was forcibly drawn through my fingers.

By experiments made carefully in the dead body (having distended the eye-ball by dropping mercury into it to give it its full globular figure), I had found that the action of the superior oblique muscle is to turn the pupil downwards and outwards, and that the inferior oblique just reverses this motion of the eye. In the above experiment there is abundance of proof that the superior oblique muscle acted, and yet the pupil was not turned downwards and outwards, therefore both oblique muscles must have been in action. Their combined action draws the eye-ball towards the nose.

In the violent spasmodic affection of the eye, when it is painfully irritated, I believe that all the muscles, both of the eye-ball and eye-lids, are excited. In quadrupeds, I have ascertained that the oblique muscles act when the haw is protruded, but I have also found that the retractor oculi alone is capable of forcing forwards the haw.

But quadrupeds having an additional apparatus of muscles to those of the human eye, are not suited for experiments intended to illustrate the motions of our eyes. The monkey has the same muscles of the eye with man.

IV. I cut across the tendon of the superior oblique muscle of the right eye of a monkey. He was very little disturbed by this experiment, and turned round his eyes with his characteristic inquiring looks, as if nothing had happened to affect the eye.

V. I divided the lower oblique muscle of the eye of a monkey. The eye was not, in any sensible manner, affected; the voluntary motions were perfect after the operation.

VI. On holding open the eyes of the monkey, which had the superior oblique muscle of the right eye divided, and waving the hand before him, the right eye turned upwards and inwards, while the other eye had a scarcely perceptible motion in the same direction. When the right eye was thus turned up, he seemed to have a difficulty in bringing it down again.

From these experiments it is proved, first, that the division of the oblique muscles does not in any degree affect the voluntary motions by which the eye is directed to objects. Secondly, that the division of the recti does not prevent the involuntary motions.

In the third place, we have also seen that in winking to avoid injury, the oblique muscles were in operation; and that the inferior oblique muscle gained in the power of elevating the eye-ball by the division of the superior oblique, its opponent.

It would appear, that the inferior oblique muscle has a power of elevating the cornea under the eye-lid, and causing the eye-ball to revolve many degrees further than the rectus superior does. For if we hold the eye open and excite it, as with a feather, the pupil will turn up quite under the upper eye-lid, and this is an involuntary act; but if we ask the person to turn the eye upwards, as in looking to the ceiling, he cannot direct the pupil beyond the margin of the eye-lid. The fact is obvious enough, and the rationale also; for to what end should there be a power of voluntarily raising the eye-ball in vision, without an accompanying action in the attollens palpebræ, and for what purpose should we have a voluntary power of turning the cornea under the eye-lid? It is obvious, that we could not extend the sphere of vision by this action, and as for the object of moistening the cornea, that is more effectually performed by the operation of the inferior obliquus*.

These revolving motions accompanying the winking motions of the eye-lids are of the utmost consequence to the preservation of the organ. A case which was some time under my observation proved this. By a defect of motion, the eye and eye-lids remained fixed, and the consequence was that the cornea inflamed and became opaque. Another curious circumstance in this case was, that when the eye-lids were closed, the patient still saw red light through the affected eye, the reason of which was that the eye-ball did not turn up when the eye-lid was closed. A case, showing this effect, will be found in the Appendix, No. XXXVII.

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* See Appendix, page xxxv.

If we close the eyes opposite to the window or before a candle, and continue to attend to the sensations of the eye, we shall still see red light coming through the eye-lids; and we may observe, at this time, that the convexity of the cornea has not changed its place; we may feel it in ourselves, or we may observe it in our neighbours. But if we make an effort to close the eye-lids (though they be already shut), we shall be in momentary darkness, because during the effort the eye-balls are then turned up. Thus it appears that the dropping of the eye-lid would make but an imperfect curtain before the eye, and the eye, to be entirely protected from the light, must have the pupil turned upwards*.

On the two Conditions of the Eye, its State of Rest, and of Activity.

The eye is subject to two conditions; a state of rest with entire oblivion of sensation, and a state of watchfulness, during which both the optic nerve and the nerve of voluntary motion are in activity. When the eye is at rest, as in sleep, or even when the eye-lids are shut, the sensation on the retina being then neglected, the voluntary muscles resign their office, and the involuntary muscles draw the pupil under the upper eye-lid. This is the condition of the organ during perfect repose*.

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* In the case above alluded to, the patient had lost both motion and the common sensibility of the eye; the offices of the third and fifth nerve were lost, yet the optic nerve retained its power, and he could see.—See also No. IX. of the Appendix.

On the other hand, there is an inseparable connexion between the exercise of the sense of vision and the exercise of the voluntary muscles of the eye. When an object is seen, we enjoy two senses; there is an impression upon the retina; but we receive also the idea of position or relation, which it is not the office of the retina to give. It is by the consciousness of the degree of effort put upon the voluntary muscles that we know the relative position of an object to ourselves. The relation existing between the office of the retina and of the voluntary muscles may be illustrated in this manner:—

Let the eyes be fixed upon an illuminated object until the retina be fatigued, and in some measure exhausted by the image, then closing the eyes, the figure of the object will continue present to them: and it is quite clear that nothing can change the place of this impression on the retina. But notwithstanding that the impression on the retina cannot be changed, the idea thence arising may. For by an exertion of the voluntary muscles of the eye-ball, the body seen will appear to change its place, and it will, to our feeling, assume different positions according to the muscle which is exercised. If we raise the pupil, we shall see the body elevated, or if we depress the pupil, we shall see the body placed below us; and all this takes place while the eye-lids are shut, and when no new impression is conveyed to the retina. The state of the retina is here associated with a consciousness of muscular exertion; and it shows that vision in its extended sense is a compound operation, the idea of the position of an object having relation to the activity of the muscles*.

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* See Nos. III. and X. of the Appendix.

We may also show, by varying this experiment, that an agitated state of the muscles, or a state of action where the muscles are at variance or confused, affects the idea of the image. If we look on the luminous body so as to make this impression on the retina, and then cover the face so as to exclude the light, keeping the eye-lids open, and if we now squint, or distort the eyes, the image which was vividly impressed upon the retina instantly disappears as if it were wiped out. Does not this circumstance take place, because the condition of the muscles thus unnaturally produced, being incongruous with the exercise of the retina, disturbs its operation?

If we move the eye by the voluntary muscles, while this impression continues on the retina, we shall have the notion of place or relation raised in the mind; but if the motion of the eye-ball be produced by any other cause, by the involuntary muscles, or by pressure from without, we shall have no corresponding change of sensation.

If we make the impression on the retina in the manner described, and shut the eyes, the image will not be elevated, although the pupils be actually raised, as it is their condition to be when the eyes are shut, because there is here no sense of voluntary exertion. If we sit at some distance from a lamp which has a cover of ground glass, and fix the eye on the centre of it, and then shut the eye and contemplate the phantom in the eye; and if, while the image continues to be present of a fine blue colour, we press the eye aside with the finger, we shall not move that phantom or image, although the circle of light produced by the pressure of the finger against the eye-ball moves with the motion of the finger.

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* Read, on this subject, the Essay of Dr. Wells on Single Vision.

May not it be accounted for in this manner? the motion produced in the eye-ball not being performed by the appropriate organs, the voluntary muscles, it conveys no sensation of change to the sensorium, and is not associated with the impression on the retina, so as to affect the idea excited in the mind. It is owing to the same cause that, when looking on the lamp, by pressing one eye, we can make two images, and we can make the one move over the other. But, if we have received the impression on the retina so as to leave the phantom visible when the eye-lids are shut, we cannot, by pressing one eye, produce any such effect. We cannot, by any degree of pressure, make that image appear to move, but the instant that the eye moves by its voluntary muscles, the image changes its place; that is, we produce the two sensations necessary to raise this idea in the mind; we have the sensation on the retina combined with the consciousness or sensation of muscular activity.

It has been said, that in this experiment the eye-ball does not move, which is the reason that the phantom does not seem to move. Then how are we to account for that effect of pressing one eye-ball when the eyes are open? for then we make the images double, and cause the one to move over the other.

It is very remarkable, that the eye will sometimes be observed to move continually, and yet, to the person having that defect, the objects viewed will appear at perfect rest. The cases in the Appendix prove this; there we find that a young woman can thread her needle at the time her eyes are in incessant motion. In this instance, when the eye-lids were held open, and the girl was made to attempt closing them, the eye-ball rolled up and remained stationary. All I can offer in explanation of this is, that she is unconscious of the motion of the eye, and that the idea of motion or change of place is not indicated. The subject is very interesting.—See Appendix, Nos. XIII., XIV., XV., XVI., XVII.

These experiments and this explanation of the effect of the associated action of the voluntary muscles of the eye-ball, appear to me to remove an obscurity in which this subject has been left by the latest writers. In a most scientific account of the eye and of optics, lately published, it is said on this question, "We know nothing more than that the mind residing, as it were, in every point of the retina, refers the impression made upon it, at each point, to a direction coinciding with the last portion of the ray which conveys the impression." The same author says, "Kepler justly ascribed erect vision from an inverted image to an operation of the mind, by which it traces the rays back to the pupil, and thus refers the lower part of the image to the upper side of the eye." What can be here meant by the mind following back the ray through the humours of the eye? It might as well follow the ray out of the eye, and like the spider feel along the line. A much greater authority says, we puzzle ourselves without necessity. "We call that the lower end of an object which is next the ground." No one can doubt that the obscurity here is because the author has not given himself room to illustrate the subject by his known ingenuity. But it appears to me, that the utmost ingenuity will be at a loss to devise an explanation of that power by which the eye becomes acquainted with the position and relation of objects, if the sense of muscular activity be excluded, which accompanies the motion of the eye-ball.

Let us consider how minute and delicate the sense of muscular motion is by which we balance the body, and by which we judge of the position of the limbs, whether during activity or rest. Let us consider how imperfect the sense of touch would be, and how little of what is actually known through the double office of muscles and nerves would be attained by the nerve of touch alone, and we shall be prepared to give more importance to the recti muscles of the eye, in aid of the sense of vision; to the offices performed by the frame-work around the eye-ball, in aid of the instrument itself.

Of the Expression of the Eye, and of the Actions of the Oblique Muscles in Disease.

If, as I have alleged, the uses of the oblique muscles of the eye have been misunderstood, and if, as I hope presently to prove, the distinctions of the nerves have been neglected, the symptoms of disease, and the sources of expression in the eye, must remain to be explained.

During sleep, in oppression of the brain, in faintness, in debility after fever, in hydrocephalus, and on the approach of death, the pupils of the eyes are elevated. If we open the eyelids of a person during sleep or insensibility, the pupils will be found elevated. Whatever be the cause of this, it will be found that it is also the cause of the expression in sickness, and pain, and exhaustion, whether of body or mind: for then the eye-lids are relaxed and fallen, and the pupils elevated so as to be half covered by the upper eye-lid*. This condition of the eye during its insensible unexercised state we are required to explain.

It is a fact familiar to pathologists, that when debility arises from affection of the brain, the influence is greatest on those muscles which are, in their natural condition, most under the command of the will. We may perceive this in the progressive stages of debility in the drunkard, when successively the muscles of the tongue, the eyes, the face, the limbs, become unmanageable; and, under the same circumstances, the muscles which have a double office, as those of the chest, lose their voluntary motions, and retain their involuntary motions, the force of the arms is gone long before the action of breathing is affected.

If we transfer this principle, and apply it to the muscles of the eye, we shall have an easy solution of the phenomena above enumerated. The recti are voluntary muscles, and they suffer debility before the oblique muscles are touched by the same condition; and the oblique muscles prevailing, roll the eye.

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* See the curious case in the Appendix, No. XVIII.

If it be farther asked, why does the eye roll upwards and inwards? we have to recollect, that this is the natural condition of the eye, its position when the eye-lids are shut and the light excluded, and the recti at rest, and the obliqui balanced.

The author has to regret that these minute circumstances regarding the action of the muscles of the eye have led him to so great a length; he hopes they are not altogether without interest in themselves, while the discussion will afford him secure ground for establishing an arrangement of the nerves of the eye, and will enable him to distinguish them according to their uses.

SECOND PART OF THE PAPER

ON

THE NERVES OF THE ORBIT.

From the Philosophical Transactions.

SECOND PART OF THE PAPER

ON

THE NERVES OF THE ORBIT.

[*Read before the Royal Society, June* 19, 1823.]

In these Papers I endeavour, to the utmost of my power, to distinguish between the facts which I am able to substantiate, and the hypothesis by which I have been directed in my inquiries. I hope that the importance of the facts may give some bias in favour of that mode of reasoning by which they have been discovered, and an additional interest to anatomical studies.

In my endeavour to arrange the nerves of the orbit, I encounter, in the first step, all the difficulties of my subject; for although there be only nine nerves properly enumerated as proceeding from the brain, six of these go to the eye; the second, third, fourth, part of the fifth, sixth, and seventh, go into the orbit, and may be said to be concentrated into a space no larger than a nut-shell.

In this investigation it is not always possible to give demonstrative evidence, or to answer opposition by cutting across a nerve; here we must proceed on a minute investigation of the anatomy, and by reasoning, rather than by experiment: yet I shall demonstrate what was stated hypothetically, in a former paper, that there is a correspondence between the compound functions of an organ and the nerves transmitted to it.

Of the Function of the Ophthalmicus, a Division of the Fifth Nerve.

We are, in the first place, to inquire by what nerve the common endowment of sensibility is bestowed upon the membranes and surfaces of the eye. On recurring to this subject we are reminded, that the sensibilities of the body differ as much in kind as in degree; that the sensation of pain is provided to rouse our activity, and guard us against violence, or, by means more direct, to excite instinctive motions, which shall anticipate the most rapid actions of the will, and serve as a more perfect safeguard. The trigeminus, or fifth nerve, bestows upon all the surfaces of the head and face, external and internal, that sensibility which is enjoyed by the rest of the body through the spinal nerves. But through some of its branches is also bestowed that distinct sense on certain parts, for the purpose of drawing the muscles into combination; as, for example, that fine sensibility of the surface of the eye to the presence of minute particles, which at once excites the flow of tears, and draws the muscles into a combination to expel the offensive matter.

It has been shown in a preceding paper, by experiment, that on dividing the branch of the fifth nerve which goes to the cheek and lips, the skin was deprived of sensibility, although in possession of other nerves, and enjoying muscular activity. The same has been proved in regard to this ophthalmic division; for if that branch of it which comes through the orbit and mounts upon the forehead be divided, the skin will be deprived of sensibility, while the motion of the eye-brow will remain entire.

These facts are so strong, that when supported by the symptoms of disease they afford no apology for deep dissection in the living animal, and authorize the conclusion, that all the branches of the same division of the nerve resemble each other in function, and bestow sensibility on the parts within, as well as on those without.

That the ophthalmic nerve may be deprived of its function, and the parts supplied by it of their sensibility, we may learn from the following instance, communicated to me by Mr. Crampton, of Dublin. To understand the inference from the short narrative, it is only necessary to remember, that the nerve in question goes through the orbit, supplying the parts contained in it, but that it also extends its branches to the angle of the eye, eye-lids, and forehead. "A few days after the discharge from the ear had ceased, the eye became entirely insensible to the touch. This loss of feeling extended to the lining of the eye-lids, to the skin covering them, and to the skin of the cheek and forehead, for about an inch surrounding the eye: it did not go beyond the middle line of the face. When she told me her eye was *dead* (as she expressed it), to be certain, I drew my finger over its surface; and so far was this from giving her pain, that she assured me she could not feel that I was touching it at all. The eye-lids made no effort to close while I was doing this, but the conjunctiva appeared sensible to the stimulus, as a number of vessels on the surface of the eye became immediately injected with blood*."

Here we have an insensibility of the eye itself corresponding with the insensibility of the skin, which latter part we know possesses sensibility through the *fifth nerve;* and we therefore conclude, that it is the affection of the same nerve near its root, to which we have to attribute the insensibility of the surfaces of the eye, as well as of the skin around the eye. We must observe in this case, as in others of which I have had experience, that the third nerve remained entire in its functions, and, in some degree, the optic nerve, during the loss of common sensibility.

It will be shown by case No. LV. of the Appendix, that the injury of the ophthalmic division of the fifth, at its root, deprived the eye of sensibility. By experiment it can farther be made evident, that the sensibility of the eye, enjoyed through the ophthalmic nerve, does not bestow on the organ directly the power of combining the muscles, either for the defence of the eye, or for any other purpose. The impression must be referred back to the brain, and the muscles be excited by their proper nerves. In experiment I have not been able to excite the motion of the eye by irritating the ophthalmic division of the fifth when its root had been divided†; and in the instance given above, the eye-lids did not move when the surface of the eye was irritated, because no sensation was conveyed inward to the sensorium, and consequently no mandate transmitted from it. The young lady could see, and could move the eye and eye-lids; the eye itself was irritated by touch, as appeared from the rising inflammation; but by the insensibility of the ophthalmic nerve, a link was lost in the relation necessary to join the action of the muscles to the sensibility of the surface.

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* See the case in the Appendix, No. LII.

† In attempting to excite the muscles of the eye by galvanism sent through the fifth nerve, the muscles of the jaw were affected.

The three cases in the Appendix, Nos. VIII., XXXVII., LIII., demonstrate the correctness of my conclusion drawn from the consideration of the anatomy; for disease at the part where the ophthalmic nerve is passing forwards entirely took away the sensibility of the surface of the eye and eye-lids, whilst vision and the motion of the eye-lids remained. By these cases it is further shown how curiously the sensibility of the surface of the eye protects it, and that when that sensibility is destroyed, although the motions of the eye-lids remain, they are not made to close the eye, to wash and clear it, and consequently inflammation and destruction of the organ follow.

Of the Nerves performing the involuntary Motions.

We have just seen that nerves in great profusion come out upon the eye-lids and forehead, and until these experiments were made, it was supposed that they directed the motions of the forehead and eye-lids. But I have found that they have nothing to do with this function. On the contrary, a very small branch of the respiratory nerve of the face, that nerve which comes out before the ear, controls the motions of the forehead and eye-lids. If this small nerve be divided, then the motions of the eye-lids are lost, and they remain open. If, on the contrary, all the nerves, that is to say, the second, third, fourth, and fifth, should be destroyed, and this small twig remain entire, the *contractions* of the eye-lids remain perfect*. The inquiries instituted in the first part of this paper give a lively idea of the consequences of the imperfection arising from the defect of this small branch of the respiratory nerve; since they show that the eye, being unguarded and unwashed, becomes dry by evaporation, inflames, and the cornea becomes opaque. It is unnecessary to point out the importance of this fact to the operating surgeon†.

I must, however, draw the reader's attention more particularly to the effect of the loss of power in the branch of the portio dura which goes to the eye-lid. The tone and action of the orbicularis being lost, the eye is protruded, or rather permitted to come forwards by the absence of opposition. This protrusion of the eye appears so like the effect of disease or of tumor in the orbit, that surgeons have concluded that the cause of paralysis externally was pressure in the orbit; thereby confounding themselves, and countenancing errors in regard to the offices of the nerves.

It has been asked, why should this nerve be called respiratory; and what have the actions of respiration to do with the eye-lids? The name was given to excite attention to certain relations, and that the connexions of remote parts might be noticed and remembered. These connexions are so curious, the knowledge of them is sometimes so useful, and they are so immediately related to the present subject, that I may be permitted to explain them.

During the state of excitement of the respiratory organs, a very extensive consent of the muscular frame is necessary to bind together and support the textures, that they may bear the strain, either during violent efforts of the body, or in coughing, sneezing, &c. We may take the act of sneezing as a familiar example of the manner in which the eye is guarded during a sudden and violent act of expiration.

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* See Appendix, Nos. VIII., IX., &c.

† See Appendix, Nos. XXXIII., XLII., &c.

At the instant of this convulsive action of the respiratory muscles, a violent impulse is communicated to the head along the column of blood in the vessels of the head and neck. Every body is sensible of the eye flashing light at this moment; but the cause is mistaken, for it is supposed to be the impulse of blood forced into the eye; whereas it is the contraction of the eye-lids to counteract the force of this impulse, and to guard the delicate texture of the eye. If we tap the eye with the finger when the eye-lids are closed, we shall be sensible of the sparks of light. We may produce the same by suddenly and forcibly closing the eye-lids in the dark; but in sneezing, the compression is both more rapid and more forcible, and as the eye-ball receives at once the impulse through the column of the blood from behind, and the resistance of the muscle on the fore part, the sparks are more brilliant. If the eye-lids be held open during the act of sneezing, no sensation of light will be experienced, because the contraction of the eye-lids upon the eye-ball is prevented.

Can we believe this action of the muscle of the eye-lids, in combination with the action of the respiratory muscles, to be through an accidental connexion? Is it not rather a provision to compress and support the vascular system of the eye, and to guard it against the violent rush of blood which attends certain acts of respiration? If we open the eye-lids of a child to examine the eye while it is crying and struggling with passion, by taking off the natural support from the eye, the blood at the same time being forced violently into the head by the act of respiration, we shall see the conjunctiva suddenly fill with blood, and the eye-lid everted.

The respiratory nerve of the face performs two offices, one of which is voluntary, as in moving the cheeks and lips in speech; and the other involuntary, as in moving the nostrils in breathing during sleep or insensibility. In like manner, that branch of the respiratory nerve which is prolonged to the eye-lids performs a double office, contracting the eye-lids by volition, and also producing those involuntary winking motions of the eye-lids which disperse the tears and preserve the lucid surface clear, whilst it causes a correspondence in the motions of the eye-lids with the act of respiration.

But it has been observed, in the first part of this paper, that the shutting of the eye-lids is not the only part of the act of preservation, and that the motions of the eye-lids are attended with a rolling of the eye-ball. How is this relation between the eye-lids and eye-ball established? This leads to an examination of the fourth nerve.

Of the Fourth Nerve, as performing an Involuntary Motion.

I should, perhaps, not touch upon this subject, because I cannot demonstrate the truth of my opinions as I have hitherto done. However, the question is this, why should the fourth nerve come from a part of the brain so far back compared with the other nerves? why should it have a different origin from the nerve which gives sensibility to the surfaces of the eye, as well as from that which gives the voluntary motions to the eye? why should it take so long a course amongst these common nerves without exchanging a filament with them?

The fourth is a fine nerve, which takes its origin from the brain, at a part remote from all the other nerves which run into the orbit. It threads the intricacies of the other nerves without touching the other muscular nerve, and is entirely given to one muscle, the superior oblique*. We may observe, too, that this singularity prevails in all animals. What office can this nerve have in reference to this one muscle? We now reflect, with increased interest, on the offices of the oblique muscles of the eye, observing that they perform an insensible rolling of the eye-ball, and hold it in a state of suspension between them. We have seen that the effect of dividing the superior oblique was to cause the eye to roll more forcibly upwards; and if we suppose that the influence of the fourth nerve is, on certain occasions, to cause a relaxation of the muscle to which it goes, the eye-ball must be then rolled upwards†.

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[*] It receives a twig from the fifth nerve.

[†] The nerves have been considered so generally as instruments for stimulating the muscles, without any thought of their acting in the opposite capacity, that some additional illustration may be necessary here. Through the nerves is established the connexion between the muscles; not only that connexion by which the muscles combine to one effort, but also that relation between the classes of muscles by which the one relaxes while the other contracts. I appended a weight to the tendon of an extensor muscle, which gently stretched it and drew out the muscle; and I found that the contraction of the opponent flexor was attended with a descent of the weight, which indicated the re-

The course of inquiry leads us, in the next place, to observe the vicinity of the root of this fourth nerve to the origin of the respiratory nerve of the face, that is, the nerve of the eye-lids, and we find them arising from nearly the same tract of fibrous substance. The column of medullary matter which constitutes that part of the medulla oblongata from which the respiratory nerves arise, terminates upwards, or at its anterior extremity, just under the corpora quadrigemina, and there the fourth arises. We have just seen that there is an intimate relation between the orbicularis muscle and the oblique muscle. Is there also a correspondence between the general act of respiration and the rolling of the eye? Led thus to make the experiment, I was gratified to find it so easy to give the proof. On stopping the nostrils with the handkerchief, every effort to blow the nose will be attended by a rapid rising of the cornea under the upper eyelid. And on every occasion when the eye-lids suffer contraction through the agency of the respiratory nerve of the face, as in sneezing, the eye-ball is rolled upwards. Is this through the agency of the fourth nerve?

I might, perhaps, be satisfied with having made the observation of these two facts; first, that there is such a combination of the motions of the eye-ball and eye-lids as I have before noticed; and secondly, that the nerves which move the eye-lids, and the

laxation of the extensor. To establish this connexion between two classes of muscles, whether they be grouped together as in the limbs, or scattered widely as the muscles of respiration, there must be particular and appropriate nerves to form this double bond, to cause them to conspire in relaxation as well as to combine in contraction. If such a relationship be established, through the distribution of nerves, between the muscles of the eye-lids and the superior oblique muscle of the eye-ball, the one will relax while the other contracts.

nerve of the obliquus muscle of the eye-ball, are associated at their roots; but I should not do full justice to this interesting subject if I did not attempt something farther. I must confess that the point of anatomy is still a desideratum. I have not in a manner satisfactory to myself made out the relation between the roots of the portio dura and of the fourth nerve.

It is plain that we must consider the nerves and muscles of the eye-lids in a double capacity, in their voluntary and involuntary actions. In the first, the motions of the eye-lids combine with the whole muscles of the eye-ball, as we may perceive in the voluntary contractions and squeezing of the eye; but in the insensible and involuntary motions of the eye-lids, there would be no sympathy with the muscles of the eye-ball, and therefore no correspondence in the motion of these parts, without a nerve of the nature of the fourth; that is, a nerve which having diverged from the root of the respiratory nerves, takes its course to the oblique muscle. Does, then, the connexion of its root declare the office of this nerve?

The expression of the eye in passion confirms the truth of this relation being established by a respiratory nerve, and consequently by a nerve of expression. In bodily pain, in agony of mind, and in all this class of passions, the eyes are raised and dragged, in conjunction with the changes to which the other features are subjected, and so in faintness and in death. If it be asked now, why the fourth nerve goes into the orbit, where there are so many nerves, why it is so distant in its origin from the other nerves, and why it sends off no twig or branch, but goes entirely to one muscle of the eye? the answer is, to provide for the insensible and instinctive rolling of the eye-ball; and to associate this motion of the eye-ball with the winking motions of the eye-lids; to establish a relation between the eye and the extended respiratory system: all tending to the security or preservation of the organ itself*.

Of the Voluntary Nerves.

The voluntary nerves of the eye are the third and sixth. The third nerve arises from the crus cerebri; that track of medullary matter which gives off all the nerves purely of volition. It is given to the muscles of the eye generally, and to no part but muscles. For these reasons we retain the name *motor oculi,* given by Willis, although his reasons for calling it so were fanciful and unsatisfactory. The fifth nerve, by its ophthalmic division, gives branches to the muscles of the eye, but not so profusely as to the surrounding parts; and not more than sufficient to give them sensibility in the degree possessed by muscular substance generally. Since the branches of the fifth nerve, transmitted to the muscles of the eye-lids and forehead, do not minister in any degree to muscular action there, it would be unwarrantable to suppose that they served the purpose of giving action to the muscles within the orbit. For these reasons, I conceive the third nerve to be that which gives volition to the muscles of the eye, and that it is, of all the nerves of the body, the most perfectly and directly under the power of the will. In No. IX. of the Appendix we may see how inflammation, involving the roots of the third pair of nerves, arrested the motions of the eye-ball.

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* For the affection of the eye in sleep, see cases in the Appendix, Nos. III., VII., X. In dying, No. XXXIX.

The *sixth nerve* is called *abducens*, and *motor externus*. There is no obscurity in this nerve with regard to its origin and distribution; it arises from the same track of medullary matter which gives rise to the motor nerves, and it is distributed to a voluntary muscle, the *rectus externus*. In this respect it is like a subdivision of the third, and without doubt it is a voluntary nerve; but there is a circumstance in its connexion which I cannot explain. It receives a gross branch from the great visceral nerve called Sympathetic. This nerve, ascending through the base of the skull, unites with the sixth nerve as it is entering the orbit. Some, having proceeded so far, would be inclined to call this an accidental connexion, and so leave it; but similar investigations for many years have brought me to the conviction that there is no accident in an animal body; and comparative anatomy proves this to be a regular established relation.

Comparative anatomy may, perhaps, assist us here. In all animals which have the retractor oculi, the sixth nerve is distributed to that muscle, as well as to the rectus externus. This would seem to imply that there is something common to the retractor oculi and the rectus externus. Now as the retractor muscle is always found where there is a haw, as in the horse, and as its action is known to be for the purpose of pushing out the haw, and removing irritation from the surface of the eye, may we not surmise that the rectus externus of the human eye is well suited to draw the eye-ball towards the inner canthus, and to produce a similar effect on the caruncle and membrana semilunaris? but in thus accounting for a certain peculiarity in the action of the sixth nerve, we have not a very satisfactory reason why it should be solitary in its origin and course*. I think this abducens muscle of the eye more subject to derangement than the other recti. Whilst this sheet is beside me I have been consulted by a patient who complains of seeing double when he looks towards the right, although his vision be perfect when his eyes are directed to the left. It is obvious that the abductor of the right eye is incapable of drawing the eye-ball beyond a certain degree: when the left eye moves round beyond this degree, the images of objects begin to separate, and become more and more apart as the left eye traverses to the right. An absolute squint, of a particular kind, in which the pupil is directed to the inner canthus, results from a greater defect of the external rectus. Does the connexion of the sixth nerve with the sympathetic account for such derangements?

I hope I have now, in a considerable degree, unravelled the intricacy of the nerves of the head, and have assigned to each nerve its proper office. In our books of anatomy the nerves are numbered according to the method of Willis; an arrangement which was made in ignorance of the distinct functions of the nerves, and merely in correspondence with the order of succession in which they appear on raising the brain.

The first nerve is provided with a sensibility to effluvia, and is properly called the olfactory nerve.

The second is the optic nerve, and all impressions upon it excite only sensations of light.

The third nerve goes to the muscles of the eye solely, and is a voluntary nerve by which the eye is directed to objects.

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* My young men are engaged in prosecuting the branch of the portio dura which penetrates the temporal fascia, and goes through the malar bone into the orbit.

The fourth nerve performs the insensible traversing motions of the eye-ball. It combines the motions of the eye-ball and eye-lids, and connects the eye with the respiratory system.

The fifth is the universal nerve of sensation to the head and face, to the skin, to the surfaces of the eye, the cavities of the nose, the mouth and tongue, and the manducatory nerve.

The sixth nerve is a muscular and voluntary nerve of the eye.

The seventh is the auditory nerve, and the division of it, called *portio dura*, is the motor nerve of the face and eye-lids, the respiratory nerve, and that on which the expression of the face depends.

The eighth, and the accessory nerve, are respiratory nerves.

The ninth nerve is the motor of the tongue.

The tenth is the first of the spinal nerves; it has a double root and a double office; it is both a muscular and a sensitive nerve. It supplies the integuments and back of the head, to which the branches of the fifth do not extend.

In concluding these papers, I hope I may be permitted to offer a few words in favour of anatomy, as better adapted for discovery than experiment. The question lies between observation and experiment, and it may be illustrated by astronomy and chemistry. In the first, the objects being beyond our influence, we make observations, not experiments; and the science at length attains a state of perfection which raises our estimate of the human intellect. In the latter, for the most part, the subjects lie out of the sphere of mutual influence; they must be brought together by artifice, and chemistry becomes a science of experiment. But anatomy is more allied to the former than to the latter science, inasmuch as things are obvious to the eyes. In the animal body the parts present distinct textures, and are laid in a natural and perfect order; it is necessary only to trace the tubes, or to observe the symmetrical order of the nervous cords, that we may discover their respective uses; the motions, whether of the solid or fluid parts, are so regular and uniform, that the whole offers a subject for observation and induction. Anatomy is already looked upon with prejudice by the thoughtless and ignorant: let not its professors unnecessarily incur the censures of the humane. Experiments have never been the means of discovery; and a survey of what has been attempted of late years in physiology will prove, that the opening of living animals has done more to perpetuate error than to confirm the just views taken from the study of anatomy and natural motions.

In a foreign review of my former papers, the results have been considered as a further proof in favour of experiments. They are, on the contrary, deductions from anatomy; and I have had recourse to experiments, not to form my own opinions, but to impress them upon others. It must be my apology, that my utmost efforts of persuasion were lost, while I urged my statements on the grounds of anatomy alone. I have made few experiments; they have been simple, and easily performed; and I hope are decisive.

If we turn to the opinions which have been entertained on the subject of the brain and nerves, we find one theory to have prevailed from the Greek authors to the time of Willis, and to have descended from him, with little alteration, to modern writers. The brain has been supposed to secrete and supply a nervous fluid, and the nerves to be the conduit-pipes for its conveyance. In every age the brain has been considered a common sensorium, and all the nerves to be capable of conveying sensation, unless when they had ganglions. If ganglions intervened, then the nerves were said to be cut off from the brain: and those so distinguished were called vital nerves, neither serving the purpose of governing the muscles, nor of conveying sensation. With all this apparent simplicity of doctrine, there never has been presented such a crude heap of errors in the history of any department of science.

These notions were obviously founded on the mistake, that the same nerve served different purposes, and that a fluid moved in the same tube outwards to stimulate the muscles, and inwards to convey sensation of external impressions. So inconsistent are those opinions with the structure of the frame, that the simplest dissection proves them to be false.

So far is it from being true that ganglions cut off sensation, that I have ascertained, and proved by experiment, that all the nerves, without a single exception, which bestow sensibility, from the top of the head to the toe, have ganglions on their roots; and those which have no ganglions are not nerves of sensation, but are for the purpose of ordering the muscular frame.

The hypothesis, that the nervous fluid streams out from the great *officina* along the nerves, has had an unfortunate influence in directing the labours of the experimentalists. During the last age it kept the pupils of Haller engaged in inquiries regarding the influence of the nerves: *de nutritione imprimis nervosa;* and *de nervorum in arterias imperio:* and the interest of this question has not subsided, but, on the contrary, has increased among us.

This notion of a fluid moving backwards and forwards in the tubes of the nerves, equally adapted to produce motion and sensation, has perpetuated the error, that the different nerves of sensation are appropriated to their offices by the texture of their extremities, "that there exists a certain relation between the softness of the nervous extremities, and the nature of the bodies which produce an impression on them." On the contrary, every nerve of sense is limited in its exercise, and can minister to certain perceptions only. Whatever may be the nature of the impulse communicated to a nerve, pressure, vibration, heat, electricity, the perception excited in the mind will have reference to the organ exercised, not to the impression made upon it. Fire will not give the sensation of heat to any nerve but that appropriated to the surface. However delicate the retina be, it does not feel like the skin. The point which pricks the skin, being thrust against the retina, will cause a spark of fire or a flash of light. The tongue enjoys two senses, touch, and taste; but by selecting the extremity of a particular nerve, or, what is the same thing, a particular papilla, we can exercise either the one or the other sense separately. If we press a needle against a nerve of touch, we shall feel the sharpness, and know the part of the tongue in contact with the point; but if we touch a nerve of taste, we shall have no perception of form or of place; we shall experience a metallic taste.

I would not say that the innovations of the celebrated Bichat did not bring us a step nearer the truth; since it was a great matter to have ascertained that the ganglions and branches of the sympathetic nerves were positively insensible and incapable of bestowing motion. It is always useful when a man of genius can present familiar subjects in a new view, since it enlivens and excites inquiry. But I think it will not be denied that Bichat paid too little regard to the opinions that prevailed; often assuming that as a novelty which really was not, and doing injustice to those who had preceded him. The best apology for this, perhaps, was the condition of his country at the time he lived. What had been termed the sympathetic system of nerves, he called the ganglionic system; although they are not more distinguishable by ganglions than the other nerves, upon which, indeed, the ganglions are remarkable for their size, number, and regularity. These ganglions must not be thrown out of the system altogether, merely because they are contained within the skull and vertebræ; a circumstance which should rather mark their importance.

The experiments of M. Le Gallois were of the rudest kind possible. The spinal marrow was cut across, or destroyed, by passing skewers into the spinal canal, and the effects were observed; as if the spinal marrow were a simple body. Whereas, by such destruction of its substance, the original ganglions, which form a series along the spine, must have been hurt; the tract of nervous matter which gives rise to the nerves of sensation; that also which gives roots to the nerves of voluntary motion; and the lateral column connected with the offices of respiration, must all have been destroyed by such coarse experiments. It cannot surprise us that the results were obscure and contradictory. But I should regret to be thought insensible to the importance of M. Le Gallois' experiments in regard to the source of the respiratory movements.

The most extravagant departure from all the legitimate modes of reasoning, although still under the colour of anatomical investigation, is the system of Dr. Gall. It is sufficient to say, that without comprehending the grand divisions of the nervous system, without a notion of the distinct properties of the individual nerves, or having made any distinction of the columns of the spinal marrow, without even having ascertained the difference of cerebrum and cerebellum, Gall proceeded to describe the brain as composed of many particular and independent organs, and to assign to each the residence of some special faculty.

When the popularity of these doctrines is considered, it may easily be conceived how difficult it has been, during their successive importations, to keep my pupils to the examples of our own great countrymen. Surely it is time that the schools of this kingdom should be distinguished from those of other countries. Let us continue to build that structure which has been commenced in the labours of the Monros and Hunters*, and which the undeserved popularity of the continental system has interrupted.

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* While printing the last sheets of these papers, I took up Mr. Hunter's work on the Animal Economy, to consult him on the distribution of the nerves to the nose. I was as much surprised with the following passage as if I had never before read it. This work of Mr. Hunter was my earliest acquisition as a medical student, and often perused with deep interest; I believe I might trace back the course of my reflections to it, although during the prosecution of this subject it never

The whole history of medical literature proves, that no solid or permanent advantage is to be gained, either to medical

occurred to me that I was indebted to him. I have often hung over the plates of Monro, certain that there was an arrangement to be discovered which would explain the seeming confusion of the nervous system, but I was not so sensible of what I owed to Mr. Hunter. I am happy that I fell so opportunely on this passage, and inexpressibly gratified to find a support of some of my opinions in such authority:—

"The nerves being in themselves, perhaps, the most difficult parts of an animal body to dissect, becomes a reason why we are still unacquainted with many of their minuter ramifications: yet, if a knowledge of these, together with that of their origin, union, and re-union, is at all connected with their physiology, the more accurately they are investigated, the more perfectly will the functions of the nerves be understood. I have no doubt, if their physiology was sufficiently known, but we should find the distribution and complication of nerves so immediately connected with their particular uses, as readily to explain many of those peculiarities for which it is now so difficult to account. What naturally leads to this opinion is, the origins and number of nerves being constantly the same; and particular nerves being invariably destined for particular parts. The fourth and sixth pair of nerves are remarkable instances of this; and we may reasonably conclude, that every part has its particular branch allotted to it; and that however complicated the distribution may be, the complication is always regular. There are some nerves which have a peculiarity in their course, as the recurrent and chorda tympani; and others which are appropriated to particular sensations, as those which go to four of the organs of sense, seeing, hearing, smelling, and tasting; and some parts of the body having peculiar sensations (as the stomach and penis), we may, without impropriety, include the fifth, or sense of feeling. This general uniformity, in course, connexion, and distribution, will lead us to suppose that there may be some other purpose to be answered more than mere mechanical convenience; for many variations have been described in the dissections of nerves, which I believe to have arisen from the blunders of the anatomist, rather than from any irregularity in their number, mode of ramifying, course, distribution, or connexion* with each or general science, by physiological experiments unconnected with anatomy. To disregard the anatomy of the nervous system, or to take it in the gross, and, influenced by a false analogy, to call life a fluid, and to attempt to direct it along a cord or a wire, is to transgress all the rules of philosophical inquiry. Were such a method continued, it would be attended with the rapid decline of anatomical studies. They would be considered as imposing restraints on genius, or be rejected as useless; and with them pathology, and the other studies which are the foundations of medical science, would fall into disuse.

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* "Here it is to be understood I do not mean lateral connexion; such as two branches uniting into one cord and then dividing; or a branch going to a part, either single or double, for still it is the same nerve; or whether a branch unites with another a little sooner or a little later, for still it is the same branch. Such effects may arise more from a variety in the shape of the bodies they belong to, than any variety in the nerves themselves."

other. We observe no such uniformity in vessels carrying fluids; but find particular purposes answered by varying their origin and distribution: the pulmonary artery answers a very different purpose, in the circulation of the blood, from that of the aorta; yet both arise from the same source, the heart. The course of the arteries is such as will convey the blood most conveniently, and, therefore, not so necessary it should be uniform; it not being very material to a part by what channel the blood is conveyed; though, in particular instances, certain purposes may be answered by a peculiarity in origin and distribution, as happens in the testicle of quadrupeds. This observation respecting arteries is likewise applicable to veins, and still more to the absorbent vessels, in which last, regularity is even less essential than in the veins. Whoever, therefore, discovers a new artery, vein, or lymphatic, adds little to the stock of physiological knowledge; but he who discovers a new nerve, or furnishes a more accurate description of the distribution of those already known, affords us information in those points which are most likely to lead to an accurate knowledge of the nervous system: for if we consider how various are the origins of the nerves, although all arising from the brain, and how different the circumstances attending them, we must suppose a variety of uses to arise out of this peculiar structure. Indeed, if we reflect on the actions arising immediately from the will, and affections of the mind, we must see thát the origin, connexion, and distribution of the nerves must be exact, as there are parts whose actions immediately depend upon such circumstances."

ON THE NERVOUS CIRCLE

WHICH CONNECTS THE

VOLUNTARY MUSCLES WITH THE BRAIN.

From the Philosophical Transactions.

ON THE NERVOUS CIRCLE, &c.

[*Read before the Royal Society, February* 16, 1826.]

In the papers which I have had the honour of addressing to the Society on the arrangement of the nerves of the human body, I have proceeded upon a comparison of the nerves of the spinal marrow with the nerves of the encephalon.

It was shown that the former were compounded of filaments possessing different powers, and that each nerve, having several properties or endowments collected within itself, proceeded to its destination without intricacy.

Unless we had discovered the composition of the roots of these nerves, we should have continued to suppose that one nerve was simple in its structure, and yet capable of bestowing the very different properties of motion and sensation.

But having satisfied myself that the roots of the spinal nerves had distinct powers, I followed up the columns of the spinal marrow; and with a knowledge of the composition of these nerves as a key, I examined the different properties of the nerves of the encephalon. Here, in the head, the nerves arise simply, and diverge to their destinations without the close compact or union which the spinal nerves form; and accordingly, the anatomy of these nerves of the brain affords satisfactory proof of their uses or functions. I am about to show that every muscle has two nerves, of different properties, supplied to it. This I could not have ascertained by examination of the spinal nerves alone, because of the intimate union of all their fibres; I had recourse therefore to the nerves of the head. By prosecuting those inquiries, which led to the distinction of the different classes of nerves, I hope now to demonstrate—*that where nerves of different functions take their origin apart and run a different course, two nerves must unite in the muscles, in order to perfect the relations between the brain and these muscles.*

It may be in the recollection of the Society, that my first paper showed the difference of the nerves of the face; by dividing one nerve, sensation was destroyed, whilst motion remained; and by dividing the other, motion was stopped, whilst sensibility remained entire.

Other parts of the nervous system since that time have engaged my attention; and it is only now that I am able to make full use of the facts announced in my first paper, which were indeed expected to lead to further improvement of our knowledge of the animal œconomy. When I distinguished the two classes of nerves going to the muscles of the face, and divided the motor nerve, and when the muscles were deprived of motion by this experiment, the natural question suggested itself—of what use are the nerves that remain entire?

For a time I believed that the fifth nerve, which is the sensitive nerve of the head and face, did not terminate in the substance of the muscles, but only passed through them to the skin; and I was the more inclined to this belief on observing that the muscular parts when exposed in surgical operations did not possess that exquisite sensibility which the profusion of the sensitive nerves would imply, or which the skin really possesses.

Still dissection did not authorise that conclusion. I traced the sensitive nerves into the substance of the muscles: I found that the fifth pair was distributed more profusely to the muscles than to the skin; and that, estimating all the nerves given to the muscles, the greater proportion belonged to the fifth or sensitive nerve, and the smaller proportion to the seventh or motor nerve. On referring to the best authorities, as Meckel[*], and my excellent preceptor Monro, the extremities of the fifth were described by them as going into the muscles; so that of this fact there cannot be a doubt.

Having in a former paper demonstrated that the portio dura of the seventh nerve was the motor of the face, and that it ran distinct from the sensitive nerve, the fifth, and observing that they joined at their extremities, or plunged together into the muscles, I was nevertheless unwilling to draw a conclusion from a single instance; and therefore cast about for other examples of the distribution of the muscular nerves. It was easy to find motor nerves in combination with sensitive nerves, for all the spinal nerves are thus composed; but we wanted a muscular nerve clear in its course, to see what alliance it would form in its ultimate distribution in the muscle. I found in the lower maxillary nerve the example I required.

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[*] Meckel de quinto Pare Nervorum Cerebri.

The fifth pair, from which this lower maxillary nerve comes, as I have elsewhere explained, is a compound nerve; that is to say, it is composed of a nerve of sensation, and a nerve of motion. It arises in two roots; one of these is the muscular nerve, the other the sensitive nerve: on this last division the Gasserian ganglion is formed. But we can trace the motor nerve clear of the ganglion and onward in its course to the muscles of the jaws, and so it enters the temporal, masseter, pterygoid, and buccinator muscles.

If all that is necessary to the action of a muscle be a nerve to excite to contraction, these branches should have been unaccompanied; but, on the contrary, I found that before these motor nerves entered the several muscles, they were joined by branches of the nerves which came through the Gasserian ganglion, and which were sensitive nerves*.

I found the same result on tracing motor nerves into the orbit, and that the sensitive division of the fifth pair of nerves was transmitted to the muscles of the eye, although these muscles were supplied by the third, fourth, and sixth nerves.

A circumstance observed on minute dissection remained unexplained—when motor nerves are proceeding to several muscles they form a plexus; that is, an interlacement and exchange of fibres takes place.

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* See plate VIII.

The muscles have no connexion with each other, they are combined by the nerves; but these nerves, instead of passing betwixt the muscles, interchange their fibres before their distribution to them, and by this means may combine the muscles into classes. The question therefore may thus be stated: why are nerves, whose office it is to convey sensation, profusely given to muscles in addition to those motor nerves which are given to excite their motions? and why do both classes of muscular nerves form plexuses?

To solve this question, we must determine whether muscles have any other purpose to serve than merely to contract under the impulse of the motor nerves. For if they have a reflective influence, and if their condition is to be felt or perceived, it will presently appear that the motor nerves are not suitable internuncii between them and the sensorium.

I shall first inquire, if it be necessary to the governance of the muscular frame, that there be a consciousness of the state or degree of action of the muscles? That we have a sense of the condition of the muscles, appears from this: that we feel the effects of over exertion and weariness, and are excruciated by spasms, and feel the irksomeness of continued position. We possess a power of weighing in the hand:—what is this but estimating the muscular force? We are sensible of the most minute changes of muscular exertion, by which we know the position of the body and limbs, when there is no other means of knowledge open to us. If a rope-dancer measure his steps by the eye, yet on the other hand a blind man can balance his body. In standing, walking, and running, every effort of the voluntary power, which gives motion to the body, is directed by a sense of the condition of the muscles; and without this sense we could not regulate their actions.

If it were necessary to enlarge on this subject, it would be easy to prove that the muscular exertions of the hand, the eye, the ear, and the tongue, are felt and estimated when we have perception through these organs of sense; and that without a sense of the actions of the muscular frame, a very principal inlet to knowledge would be cut off.

If it be granted, that there must be a sense of the condition of the muscle, we have next to show that a motor nerve is not a conductor towards the brain, and that it cannot perform the office of a sensitive nerve.

Without attempting to determine the cause, whether depending on the structure of the nervous cord, or the nature or the source of the fluid contained, a pure or simple nerve has the influence propagated along it in one direction only, and not backwards and forwards; it has no reflected operation or power retrograde; it does not both act from and to the sensorium.

Indeed reason without experience would lead us to conclude, that whatever may be the state, or the nature of the activity of a motor nerve during exertion, it supposes an energy proceeding *from* the brain *towards* the muscles, and precludes the activity of the same nerve in the opposite direction at the same moment. It does not seem possible therefore that a motor nerve can be the means of communicating the condition of the muscles to the brain.

Expose the two nerves of a muscle; irritate one of them, and the muscle will act; irritate the other, and the muscle will remain at rest. Cut across the nerve which had the power of exciting the muscle, and stimulate the one which is undivided, the animal will give indication of pain; but although the nerve be injured so as to cause universal agitation, the muscle with which it is directly connected does not move. Both nerves being cut across, we shall still find that by exciting one nerve the muscle is made to act, even days after the nerve has been divided; but the other nerve has no influence at all.

Anatomy forbids us to hope that the experiment will be as decisive when we apply the irritants to the extremities of the divided nerves which are connected with the brain; for all the muscular nerves receive more or less minute filaments of sensitive nerves, and these we can trace into them by the knife, and consequently they will indicate a certain degree of sensibility when hurt. To expose these nerves near their origins, and before any filament of a sensitive nerve mingles with them, requires the operator to cut deep, to break up the bones, and to divide the blood-vessels. All such experiments are much better omitted; they never can lead to satisfactory conclusions.

Experience on the human subject most abundantly illustrates these facts. For example:—a patient of mine having, by a tumour pressing the nerves of the orbit, lost the sensibility of the eye and eye-lids, she retained the motion of the eye-lids by the portio dura coming round externally and escaping from the pressure which injured the other nerves. Here the course of sensibility backwards to the brain was cut off, while the course of volition forwards was free; she could not tell whether the eye-lid was open or shut, but being asked to shut the eye which was already closed, she acted with the orbicular muscle and puckered the eye-lids. Nay, when the eye was scarified she had no sensation, and did not wink with the eye-lids. There was no motion in this case, because the sensitive fifth pair had lost its power, although she could command the motion by voluntary exertion. It will further be remarked in the case No. VIII. page xxvii., that the patient shrunk and winked when a blow was aimed at the eye, although there was no motion when the eye was touched with a feather. Here the sensation was conveyed backwards by the optic nerve, the fifth having lost its power.

In another instance, when the eye was insensible, touching the eye gave rise to a blush of redness and to inflammation, because the *part* was excited, but the muscles were not called into action. The relations which connect the sensibility of the eye with the motions of the eye and eye-lid are established in the roots of the fifth and seventh in the brain; the loss of function of the fifth nerve therefore interrupted the circle. Here too the motor nerve of the eye-lid was perfect, and the eye-lid readily acted under the influence of the will; but when the eye-lid was touched or pricked it communicated no sensation. Is this insensibility of a motor nerve owing to the course of its influence being from the brain, and not towards it? When the nostril had lost its sensibility from an affection of the fifth pair, we could not excite sneezing*; when the tongue and cheek had lost sensibility, the morsel was permitted to remain between the tongue and the cheek until it was offensive, although the motions both of the tongue and the cheek were perfect[*]. All these phenomena correspond with the experiments on animals[†].

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* See Appendix, Nos. XXX. and LV., page cxii.

Now it appears the muscle has a nerve in addition to the motor nerve, which being necessary to its perfect function, equally deserves the name of muscular. This nerve however has no direct power over the muscle, but circuitously through the brain, and by exciting sensation it may become a cause of action.

Between the brain and the muscles there is a circle of nerves; one nerve conveys the influence from the brain to the muscle, another gives the sense of the condition of the muscle to the brain. If the circle be broken by the division of the motor nerve, motion ceases; if it be broken by the division of the other nerve, there is no longer a sense of the condition of the muscle, and therefore no regulation of its activity[‡].

We have noticed, that there is a plexus formed both on the nerves which convey the will to the muscles, and on the nerves which give the sense of the condition of the muscles.

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[*] See Appendix, No. XXXVII.

[†] See further in the Appendix, page clv. See also the case communicated by Dr. Ley, and No. LXXXVI.

[‡] Thus led to conclude that there is motion in a circle, we nevertheless cannot adopt the hypothesis of circulating fluids. That a fluid does not proceed from the brain, we may learn from this; that on touching the end of a motor nerve which has been some days separated from the brain, the muscle is excited as when the nerve was first divided. The property, however it may be defined, is therefore in the nerve. Our language might perhaps be made more precise if we used terms which implied the course of nervous influence, whether from or towards the brain; but it will be difficult to express this without the aid of hypothesis.

The reason of this I apprehend to be that the nerves must correspond with the muscles, and consequently with one another. If the motor nerve has to arrange the action of several muscles so as to produce a variety of motions, the combinations must be formed by the interchange of filaments among the nerves before they enter the muscles, as there is no connexion between the muscles themselves. As the various combinations of the muscles have a relation with the motor nerves, the same relations must be established by those nerves which convey the impression of their combinations, and a similar plexus or interchange of filaments therefore characterizes both*.

We have seen that the returning muscular nerves are associated with the nerves of sensibility to the skin, but they are probably very distinct in their endowments, since there is a great difference between conveying the sense of external impressions, and that of muscular action.

In surgical operations the fact is forced upon our attention, that the pain of cutting the skin is exquisite, compared with that of cutting the muscles; but we must remember that pain is a modification of the endowment of a nerve, serving as a guard to the surface, and to the deeper parts consequently. This is further exemplified in the sensibility of the skin to heat; whilst, on the contrary, a muscle touched with a hot or cold sponge during an operation, gives no token of the change of temperature but by the degree of pain.

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* The pupils must be put on the pursuit of some of the points of the anatomy connected with this subject.

Many of the nerves which perform the most delicate operations in the economy, are not more sensible to pain than the common texture of the frame. The lower degree of sensibility to pain possessed by the muscles, and their insensibility to heat, is no argument against their having nerves which are alive to the most minute changes of action in their fibres.

When the anatomist shall find both the portio dura of the seventh and the fifth going to the integuments of the head and face, he may naturally ask, why are there two nerves to the surface? and he will probably reflect, that although the principal office of the nerves of the skin is to convey impression to the sensorium, yet the influence of the mind is conveyed to the surface. The condition of the mind in passion, for example, is as forcibly communicated to the skin as to the muscles themselves; and therefore if a branch of the fifth be necessary to convey sensation from the surface to the sensorium, the seventh is necessary to the change of vascular action, and to the condition of the pores when affected by a cause proceeding from within, outwards.

I feel a hesitation when I reason upon any other ground than on the facts of anatomy. Experiments are more apt to be misinterpreted; and the very circumstance of a motor and sensitive nerve being generally combined together, affords a pregnant source of error.

It is natural to suppose that the galvanic influence might be brought to bear on this subject; but I may be permitted to suggest to any one who pursues it in this way, that it will be necessary to distinguish the effects produced by the nerve as a mere conductor, and when performing its living functions. The nerve, dead or alive, may convey the galvanic power like a wet cord; but if the nerve be in possession of its living property, a great deal will depend on the direction in which the galvanic fluid is transmitted. If it be transmitted against the course of the nervous influence, it will reach the muscles and act feebly, although the power of the nerve be not in this case exercised upon the muscles; but if it be transmitted in the proper course towards the muscles, the nerve itself will be excited, and its power propagated so as to produce violent action in the corresponding muscles.

APPENDIX,

CONTAINING

CASES AND LETTERS OF CONSULTATION

ON

NERVOUS DISEASES,

SUBMITTED TO THE AUTHOR

SINCE

THE PUBLICATION OF HIS PAPERS ON THE FUNCTIONS OF THE NERVES, IN THE TRANSACTIONS OF THE ROYAL SOCIETY,

AND

ILLUSTRATIVE OF THE FACTS ANNOUNCED IN THE PRECEDING PAGES.

CONSULTATIONS AND CASES

ILLUSTRATIVE OF

THE FACTS ANNOUNCED IN THE PRECEDING PAPERS.

The following sheets refer entirely to the nervous system. They contain notes of cases, and such letters of consultation, as the author conceived himself at liberty to publish. They confirm and illustrate the opinions delivered in the preceding papers; and with other beneficial results he hopes they will tend to show the importance of anatomy in questions the most strictly practical.

Systematic authors, possessing the highest talents for investigation of disease, and great learning, have notwithstanding run into much confusion on the disorders of the nerves. Nor can this surprise any one who considers the imperfect notions that prevailed on the nervous system: the obscurity regarding the different systems of the nerves, and the variety of the functions that were indiscriminately given to the branches from whatever root derived.

The author has attempted no system; there are here accurate reports only. The facts stand isolated and abrupt, because noted at intervals; it will be long, he apprehends, before the united labours of the profession can enable the medical author to arrange the diseases of the nerves, and to describe them accurately; we are obviously in a very early stage of the inquiry.

He has to add that whenever he could receive the testimony of others he has preferred their words to his own. When an interesting case presented in the hospital, for example, he has been in the habit of asking an intelligent pupil to make a note of it, without informing him of the object of the inquiry. This method of taking evidence, as to matters of fact, may have produced an irregularity in these notes, which, however, proceeds from the reverse of carelessness.

The first division of cases will illustrate the first and second papers, in which it is demonstrated, that the branches of the fifth pair of nerves give sensibility to the head and face; and that the motions of the eye-lids, cheeks, nostrils, and lips, result from the influence of the *Portio dura* of the seventh nerve.

PARALYTIC AFFECTION OF THE FACE*.

Trismus diastrophe. Diastrophe Galeni. Oris tortura paralytica Linnæi. Est distorsio oris versus alterutrum latus, ob oppositi lateris hemiplegiam, unde musculus zygomaticus et buccinator lateris sani os ad se trahunt et tractum detinent, paralyseos aut apoplexiæ prodromus aut sequela: eamdem curam expostulans.—*Sauvages.*

In consultation the following letter was put into my hands:

No. I.

" It is in my power to relieve your mind of much anxiety. My experience has furnished me with five cases of paralysis of the muscles of the face of one side, completely local, and in no way connected with the *encephalon.* They all did well without general bleeding. Dr. B. and Dr. S. met me lately in consultation on the case of a lady in the eighth month of her pregnancy, who suffered this partial paralysis of the muscles on one side of her face, from the action of mercury on her mouth. The sore mouth inflaming, a lymphatic gland between the mastoid process and the angle of the jaw compressed a branch of the seventh pair of nerves. The muscles of the face on that side were so completely paralysed, that the cheek was drawn by their antagonists, and the mouth disfigured.

" Dr. B. and Dr. S. suspected pressure on the brain at the origin of the fifth pair of nerves. But I took the liberty of stating the discoveries of

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* To know the previous state of opinions, and the point from whence we start, read a paper on this subject, Transactions of the College of Physicians, vol. i.

Mr. Charles Bell, and proved to them by other cases which had fallen under my notice, that there was no danger, and that the brain was not implicated.

"This case, in the course of a fortnight, did well under the use of mild laxatives, leeches behind the ears, and a small blister."

I owe the following case to the kindness of Dr. Gregory, who has vouched for the accuracy with which the account of symptoms has been drawn up by a medical friend. The patient was at the time under Dr. Gregory's care.

No. II.

Case of Paralysis of the Face.

"John Chapman, æt. 45, foreman to a builder, January, 1827. He says, for five years past he has not considered himself in a good state of health. Three years ago, after a few days' illness, he was seized with paralysis of his lower extremities: he recovered from this attack, and resumed his occupations. He had an abscess in his right ear, which burst, and continued to discharge matter: he cannot precisely state when the disease of his ear commenced. For eighteen months following the attack of paraplegia, he was subject to fits of the ague; afterwards he was free from any complaint, except that his ear discharged a thin fœtid matter. In August last, while coughing or sneezing, a substance which he describes as cylindrical and hollow, about an inch in length, dropped from his right ear: from this time the discharge ceased. Three weeks after this period, his wife first observed that his face was distorted to one side. On presenting himself to his medical attendant in the country, he was told that he was going to have another attack of palsy, and was ordered to be cupped and blistered, &c. His daughter says, his countenance appears now exactly in the same condition as when first observed to be distorted.

"All the muscles of the right side of his face, which are controlled by the influence of the portio dura, or respiratory nerve of the face, are completely paralysed. He cannot elevate his eyebrow nor frown; there is a line nearly in the centre of his forehead, dividing the bulging of the muscles on the left side from the smooth uncontracted state of those on the right side. He cannot close the eyelids of the right eye; they remain always open: when he makes the attempt to close them, we see the eye-ball rolling upwards. The secretion of tears is very abundant, so as to render this eye more glistening than the other: he complains of the inconvenience produced by its continually weeping; he also attributes a dimness of vision in the right eye to this cause. From the nature of his occupations, he is constantly troubled by the dust getting into this eye; but he has acquired a readiness of pulling down the eye-lid with his finger, to defend it. His daughter says, that when she has seen him asleep, only the white of his eye was visible.

" His right nostril is collapsed. The muscles of the cheek and mouth are relaxed and dragged to the left side. When he speaks, the cheek flaps like a blind before an open window, and if he attempt to utter a word with peculiar emphasis, the air escapes from the corner of his mouth, like the whiff of a person smoking. He sometimes experiences a difficulty of swallowing, at the moment when the morsel is thrown back into the fauces.

" The sensibility of the right side of his face is natural. When he clenches his jaws, the masseter muscles can be felt equally hard and contracted on both sides of his face. He can protrude his tongue, and twist it to either side. He is deaf in the right ear."

¶ The peculiarity of the preceding case is paralysis occurring in two instances in the same patient, but from different causes. It was natural for the physician in the country, on perceiving paralysis come upon the face, to suppose it was the precursor of a second attack of paraplegia. But comparing the symptoms with those of other cases in this Appendix, and more especially observing the connexion betwixt the discharge from the ear and the paralysis of the face, the reader will be inclined to believe with me, that the second attack arose from the affection of the portio dura in its course through the temporal bone.

No. III.

Clinical Lecture on Partial Paralysis of the Face, delivered by Mr. Bell, at the Middlesex Hospital.

Case.—Daniel Quick, æt. 70. One of the young gentlemen attending the hospital brought this old man to show him to Mr. Bell. He had observed him sweeping the streets: one of his eyes was staring wide open, and red: the cheek on the same side was loose and pendulous, and the mouth was dragged to one side. His attention being attracted by these appearances, he was led to question the man as to the cause of them.

Twelve years ago his face was "all right;" but, he said, pointing to a scar in the angle of the jaw on the left side, ever since he received a wound in that part, from being tossed by a bullock, his face has been in the same condition in which it now is. The horn of the animal had entered his neck just below the ear; he was lifted from the ground, and when he fell, the blood gushed out, according to his expression, "as when a sheep is stuck." A surgeon sewed up the wound, and "made a capital cure of it."

The left side of his face forms a remarkable contrast with the other. Upon the forehead the skin lies flat and smooth, there being no wrinkles as on the right side; and when he frowns, the left eye-brow moves only a little, by the action of the muscles on the right side dragging it towards them. The eye remains permanently open: there are none of the common winking motions: and when he is asked to close the eye forcibly, although he makes the attempt, there is not the slightest motion observed in the eye-lids. The lower eye-lid hangs down considerably, so that the conjunctiva is much exposed; and there is a fulness in its vessels, apparently consequent on repeated attacks of inflammation. This eye has been the source of great distress to him, especially during the summer season, owing to the dust and the brightness of the sun both injuring it. His wife, he said, has told him that he never closes this left eye, not even when he is asleep. In the repeated attempts which he made, although the eye-lids did not move, it was always observed that the cornea was tilted upwards, so as to be completely concealed behind the upper eye-lid. This is a motion of the eye-ball which Mr. Bell first described in his papers upon the nerves within the orbit; and he has on former occasions pointed it out to the pupils at this hospital. Being curious to discover the position of the eye during sleep, the reporter of this case went to the patient's house. His wife told him, that what her husband said about his never closing the left eye was correct, and that it was open even while he was sound asleep. Being then asked in what direction he appeared to be looking while he was asleep, whether he fixed his eyes on her? "No, sir," she said, "that cannot be, for there is only the white of his eye seen." Being further questioned, she said, that a small part only of the black of his eye could be perceived, at the margin of the eye-lid; but she was quite sure he could not see her.

The muscles of the cheek on the left side are wasted, and there appears to remain nothing but the thin integuments, which hang upon the side of the face, as if dead, without having any action in them, or wrinkles, as in the right cheek; and when he speaks, this cheek is alternately puffed out and then collapsed, the air first distending it, as it were a bag, and then escaping at the angle of the mouth.

The left nostril lies flat, and is not at all distended while he draws a deep breath, or makes the motion of sniffing up.

His whole mouth is drawn to the right side, thus producing most remarkable distortion of the face. Whatever action there is in the mouth is altogether owing to the contraction of the muscles on the right side of it; the left angle hangs loose, and is quite passive; and the saliva is allowed to flow constantly out upon the lower lip on this side.

In regard to sensation, that is wanting only in the integuments over the cicatrix, and a little way above it, just before the ear. Otherwise, in all the parts of the head and face, it is quite perfect.

Gentlemen, I have brought this man to you, that you might yourselves examine him, and be satisfied as to certain facts, which men, high in science, and respectable in our profession, have denied with a heat and pertinacity which I can never understand, and which surely ought not to belong to such an inquiry.

For years I had the conviction that the nerves, and especially the nerves of the face, had distinct functions. I was deterred from announcing my opinions because I conceived it impossible but that experience and observation must have long ago ascertained the fact. Yes, gentlemen, from the dissection, I conceived that the branches of the fifth nerve, and of the portio dura of the seventh nerve, must have distinct offices. But then, I said, if it were so, the fact could not be so long concealed; these nerves are cut by surgeons every day; they are exposed in wounds; and yet I find no surmise to countenance this idea. Were I to refer to my note books, I could prove to you how anxiously I looked around for some circumstance to support this opinion; and although of late years many such cases as the present have been submitted to me, there was a time in which I would have given all that I was worth to have such proofs as you have now before you.

Some will contend about the propriety of making experiments on the living—none will hesitate to say that it is our duty to observe accurately, when an accident may be converted into an experiment. This poor man was tossed by a bull: the horn went in here at the angle of the jaw, and he hung suspended upon it, until the integuments before the ear giving way, he dropped. The blood flowed copiously, and he will tell you that he heard it splashing upon the ground: notwithstanding, he expresses, with gratitude, that his doctor made a famous cure of it. The point of the horn had entered behind the upright portion of the jaw, and had hooked up and torn across the portio dura of the seventh, where it is coming forwards from the stylo-mastoid foramen. I wish you to direct your whole attention to the effects of the division of this nerve; since it is as much of the nature of an experiment as if you had tied an animal neck and heel, and had divided the nerve with your scalpel.

You have observed the remarkable distortion of the whole face; and that one side is become as it were a dead mass, incapable of motion, or of expression of any kind; an effect which, heretofore, any medical man would have supposed could only be produced by the division of all the six nerves that go to the side of the face; whereas you see the effect has been produced by the destruction of one only. You observe, by the answers to my questions, that whilst motion is gone, sensibility remains. And you cannot resist the conviction that the remaining sensibility is owing to the entireness of the branches of the fifth pair, which come out through the orbit, and through the upper and lower maxillary bones; whilst the loss of motion has resulted from the tearing of the portio dura. Nor is this a solitary case in this hospital. A patient was brought in who had put a pistol to his ear; which, strange to say, did not immediately destroy him, nor at once deprive him of sense; although ultimately he died. The temporal bone was shattered, and the portio dura torn: and the paralysis of the muscles of the face was as complete as it is here.

[Mr. Bell.—Now, my friend, shut this left eye.

Patient.—No, sir, I cannot do that: my wife says I never shut my eye.

Mr. Bell.—But make an attempt: close both your eyes, as if you were going to sleep.

The patient makes the attempt, but still adds, it is needless; "my wife says I never shut this eye." In the attempt, we observed, that when the right eye-lids were closed, the left eye-ball was rolled up, so as to be concealed under the upper eye-lid.]

Mr. Bell continued.—You witness the fact, then, gentlemen, that there is this very remarkable turning up of the cornea in the attempt to close the eye-lids; and you comprehend how this takes place: the imperfection is only in the eye-lids; and, although the will cannot reach them, owing to the division of the portio dura, yet the rolling of the eye is performed, because the nerves to the oblique muscles within the orbit are entire. Before you, then, there can be no denying this revolving of the eye; and in future you will allow no question about it.

If you will take the trouble to inquire, this man will tell you that he is not at all aware of the eye being turned up; although he can turn it up by a voluntary act, and be conscious of it at the same time. This is altogether an instinctive or involuntary action in the eye-ball; and you do not observe it merely because it is a part of the protecting action, accompanied with the rapid closing of the eye-lid which conceals it. You may, however, feel it at any time, by putting your finger upon the closed eye-lid; and then, acting with the eye-lids to close them more firmly, you will feel the convexity of the cornea slip upwards: or, spread out the eye-lid upon a friend's eye with your fingers, until you see the cornea under the tense skin: then ask him to make the effort to wink, and you will see the convex body slip up and disappear.

Without going far into this question, I would just observe that this motion is altogether for the protection of the eye: and you see that there are two parts of the same action; first, the dropping of the eye-lid, like a curtain; secondly, the raising of the cornea towards the lachrymal ducts; by which these ducts are stretched, and a copious secretion bedews the cornea.

The cutting of the portio dura, or of that branch of it which goes towards the eye-lids, paralyses the orbicularis palpebrarum, and they therefore remain open. This has a very bad effect, by causing inflammation of the eye; and, in this case, you perceive the effects of this inflammation, in the eversion of the lower eye-lid, and the redness of the tunica conjunctiva —the circumstance, indeed, which first attracted our friend's attention to this man on passing him in the street. But the cornea is still safe; and you see how this is: although the eye-lid does not descend, yet the eye ascends to the eye-lid: and it is wiped, cleaned, and moistened, by this partial performance of the instinctive act of winking. We have had in this house a girl in whom the eye-lids of both sides were so adherent to the eye-brows and cheeks, from a burn, that they were not recognizable from the common skin. The eye-balls stood out naked; and although the horrible and preternatural appearance of the girl, consequent upon the staring eye-balls, was increased by the red circles of inflammation around them, yet the cornea were preserved transparent, by their being raised in the frequent act of winking, and dipped, as it were, at the lachrymal fountain. In the case before you, although the eye is not altogether destroyed by inflammation, you see the very unpleasant effects produced by the deprivation of this branch of nerve, in the exposure, inflammation, and suffusion of the surfaces.

The next thing that is curious is the condition of his eye in sleep. You find it stated that the cornea goes up during sleep; for his wife being asked, if, since the eye-lid remained open, he continued looking at her when asleep, she answered, "that cannot be, for only the white of the eye is seen." You have here, then, all but ocular demonstration of what I have elsewhere affirmed, that there is a particular position of the eye-ball, or, in other words, another condition of the muscles of the eye-ball, peculiar to the state of sleep. Indeed, it must be obvious to you that if, in this man, the pupil were not covered, and the cornea moistened during sleep, there would be an incessant irritation upon the eye, from the entrance of the light, and the evaporation of the moisture from the cornea. But, however interesting in a philosophical light, this is not practical; and, therefore, I am not at liberty to detain you longer upon it in this place.

[Mr. Bell.—Now, my friend, let us see you take a snuff: (the patient put the pinch to the right nostril). But why do you not snuff with the left side?

Patient.—Because it does not go high enough to let me feel it.

Mr. Bell.—Can you breathe through that left nostril?

Patient.—My wife says I cannot.

A bottle of carbonate of ammonia being put to this nostril, he said, with some emphasis, " I can feel that."]

You see, gentlemen, that this honest fellow bids fair to have domestic peace: he confides more in his wife's authority than in his own sensations. But you will have no difficulty in understanding how the destruction of the portio dura affects the sense of smelling, and destroys, in a great measure, the gratification of snuffing. The cartilages of the nose form a very curious structure; and, you know, are moved by four appropriate muscles, these muscles being governed by the respiratory nerve of the face or portio dura. Every violent inspiration is attended with an excitement of these muscles, and an expansion of the tube: were this wanting, you see what the effect would be. At the moment of a sudden inspiration, instead of the tubes for the passage of the air being enlarged proportionally, they would hang, like this man's nostril, upon the left side, which you see forms a loose membranous slit; and be more apt to close and cause a sniffling, in drawing the breath, than to become inflated to admit the air freely. In smelling, or in snuffing, there is such an action of these muscles as produces both a narrowing and a new direction of the lower part of the tube of the nostril; by which the air, and whatever that air has suspended in it, is drawn forcibly upwards to the more sensitive part of the Schneiderian membrane. Our friend here finds it a mere waste of snuff to put it into this nostril: he tells you it does not go high enough: he can draw it in, but he cannot make it mount. You perceive, then, that although the function of the olfactory nerve remains entire, the loss of the portio dura is attended with a destruction of that apparatus which is made subservient to the organ of smelling.

[Mr. Bell.—Do you put the morsel into the left side of your mouth?

Patient.—Yes, but I *wumble* it over to the other side.

He now got a pot of porter, and as he swallowed, there was a flapping of the paralysed cheek; he said that he required time, or it would fall out of his mouth again. Mr. Bell thought he felt a stringy or active condition of the buccinator, but recommended us to give him a pot some other day, and ascertain this.

He was now asked if he could laugh; and, quaintly enough, he answered, "Yes, when he had got something to laugh at;" and on this he exhibited a very singular distortion of countenance: at each cachinnation his left cheek was puffed out, flapping like a loose sail; and the forehead and eye-lids of this side remained perfectly still; whilst upon the right side the whole mouth was drawn upwards, the cheeks were strongly wrinkled, and the eye-lids puckered.]

You know, gentlemen, that I have classed the portio dura of the seventh pair with the superadded respiratory nerves; as, besides having the voluntary power over the muscles of the face, it produces that consent among them with the organs of respiration, which continues when the voluntary power is gone. And as this portio dura takes its circuitous course, for the purpose of associating parts necessary to the act of respiration, for the same reason it must be the nerve of expression; since the self-same parts are the organs of expression that are the organs of respiration. Suppose that a filament of the fifth had been the link of connexion to establish the sympathies among the features of the face (as it was once supposed that its ganglion was for that purpose), then the nerve of expression in the face would have been separated from the other parts of the organs of respiration, and, consequently, from expression. You witness, however, in this patient, the fact: you see that with the destruction of this nerve, the expression in laughing is gone from the side of the face. You will, perhaps, take it on my authority, that crying would be all on one side of the face too. The neck, shoulders, and chest, would be equally incapable of agitation in laughter or weeping, if the respective nerves of this class were divided. Now these are the extremes of expression; and all the intermediate gradations, which are the signs of emotion, are frequently lost.

This subject is not uninteresting to you in practice: for as you find the portio dura in possession of distinct properties, all of them related to respiration—breathing, speech, and expression; you will not be surprised that these functions are occasionally differently affected; as, for example, a man will continue to possess the power over the nerve, as the nerve of speech, and yet he will be incapable of expressing the usual signs in laughter, or in crying. In short, you find that your patient sometimes exhibits paralysis of the side of the face only when he smiles or laughs; at other times it is not observable. We really have no reason to conclude that the one property of a nerve requires a finer organization than another. I would rather suppose that this power of expression is constituted with a finer relation to the condition of the mind, and of the body; and, therefore, we may suppose is more easily affected by slighter derangements.

No. IV.

Proposal to divide the Portio Dura.

"Sir,—Having attended your brother's lectures during my studies in Edinburgh, and read several of the works of both, I am induced to apply to you in behalf of a very respectable patient, Mr. —— of this place. He is a healthy strong man of fifty, who has been affected for nearly twenty years with an involuntary contraction of the muscles of the side of his face, drawing up the angle of the mouth, and giving to the palpebræ a winking motion, so remarkable, that it may be seen at a considerable distance. This hurts his feelings so much, that he has lately come to the determination of having an operation performed on the nerves of the part affected.

"He has never had any pain during the convulsive actions but once for two or three days, when it was so severe as to resemble, in many symptoms, the *tic douloureux.* I am ignorant that the operation has been ever performed for such an affection. But as the disease has become much more troublesome, I should think there would be no impropriety in trying it.

"Should you be enabled to give any encouragement to its performance, he will proceed to London immediately."

Remark.—In a note on the following page, it will be seen, that a gentleman came to me to have the branches of the fifth nerve, on one side of the face, cut, in order to balance the paralytic features of the other. A singular consequence would have resulted from such an operation. The patient would have been deprived of sensibility on one side of his face, and of motion on the other!

If the subject of the present consultation had submitted to have the nerve cut, his eye would have remained open, for the *attollens palpebræ* being supplied by the third nerve, and the *orbicularis palpebrarum* by the seventh, the cutting of the latter would have paralysed the eye-lids: they would have remained open, and the eye would have become inflamed, and probably opaque. There would have been greater deformity, and blindness also.

How such proposals are made is obvious enough. Surgeons have been, of late years, cutting the branches of the fifth pair with impunity; that is to say, no ugly paralysis resulted from these operations.

Answer to the foregoing Letter:

34, Soho-square, May 16.

"Dear Sir,—I am happy you have communicated this case of Mr. —— to me, for some serious considerations present themselves, before attempting to remedy his symptoms by an operation. The nerve affected is the portio dura of the seventh pair, which comes out before the ear, and spreads from that over the face. It is very liable to the affections which you describe. But before dividing it we must consider its functions, which are very important: through it, we are enabled to close the eye-lids, and through it we move the lips in speaking. Although we leave the branches of the fifth pair going to these parts, yet, by the division of this portio dura of the seventh pair, we deprive them of all motion. The effect upon the eye is very serious: it remains open, and the exposure excites inflammation and opacity.

"These you will see are strong reasons against cutting across the nerve. Perhaps you are not aware that the dividing of this portio dura would not at all diminish the pain, the sensibility of the side of the face depending altogether upon the fifth pair. I fear, therefore, you must limit your attempts to relieve your patient to medical treatment. You will find this twitching to depend a good deal on the state of the digestion. Anodyne liniments rubbed in the course of the nerve, and pressure to limit the motion of the parts spasmodically affected, I have found attended with advantage. The pressure, which restrains this spasmodic motion, tends to break that habit, on which, in a great measure, it at length depends, however originally produced: and indeed it is this circumstance, the continuance of the symptoms for twenty years, which forbids me being sanguine in the expectation of your effecting a cure.

"Charles Bell."

No. V.

Proposal to divide the branches of the Fifth Pair.

A gentleman, in the vigour of life, came into my room to consult me, having the most remarkable distortion of countenance I had ever seen. He proceeded to state to me what he conceived to be the cause of this paralytic affection of one side of his face: he had been knocked down by a blow upon the ear, and had remained a whole night insensible, with bleeding from the ear, from which time his features had been thus drawn to the opposite side. I thought I should give him comfort by stating to him that this was a paralysis attributable to the injury of the bone, and that, as it had not proceeded from an apoplectic tendency, there was no danger of a future attack or of increase of the paralysis. But this was not what he expected from me; he had consulted my brother, then at Rome, who had proposed to cure him by an operation.

I was quite at a loss to conceive what operation his ingenuity had contrived to relieve so remarkable a deformity. The gentleman mentioned that it had been intended to make three small incisions on different parts of his face, so as to restore the balance of his features: and he was obviously disappointed in finding me less intelligent, or less able than he had expected, and we parted.

On reflecting on the conversation of this gentleman, it occurred to me, that my brother, believing that the paralysis had arisen from an injury of the fifth nerve, had proposed to restore the features to an equilibrium by dividing the branches of the same nerve on the opposite side; trusting, no doubt, to the features being still animated by the seventh pair of nerves. A singular consequence would have resulted from such an operation. The features would have remained drawn to the same side as before, and he would have been deprived of all sensibility of that side! If it was designed to have cut the *portio dura* of the side contracted, a more unhappy consequence would have resulted; for he could never afterwards have spoken, or even have kept his lips to his teeth, or retained the saliva. The features of both sides would have fallen in relaxation, the eye would have remained uncovered, and he would have lost his sight by the inflammation and opacity consequent on its continual exposure!

It must, indeed, appear a singular circumstance now, that so many surgeons were cutting the branches of the fifth pair of nerves for the tic douloureux, without being led to inquire more particularly into the functions of the several nerves of the face. We see how nearly my brother's ingenuity was leading him wrong, from having often cut the fifth pair without producing horrible distortion. And I believe that the very same mistake led a gentleman to say that I had not cut the frontal branch of the fifth pair of nerves on the face of a nobleman, when in fact I had only cut that branch and had not interfered with the branches of the *portio dura*, and, consequently, had produced no effect on the muscles of the eye-brow. All these circumstances, I hope, tend to enforce the importance of anatomy.

I find the following observation in a review of a former edition of this work:—" It would appear that Mr. Bell has not consulted Dr. Darwin's Zoonomia: for we find there a striking illustration of his opinion. A gentleman having tic douloureux was under the care of three eminent practitioners, Dr. Darwin, Mr. Cruickshanks, and Mr. Thomas. Nine incisions (together with some smaller ones) were made on the left side of his face:

every nerve of that side of the face, including the branches of the fifth pair and of the seventh, were divided; yet there is not one word concerning the defect of sensation or of motion. The patient set out for Leicestershire perfectly restored."

No. VI.

Paralysis of the Face.

"My dear Sir,—Being informed by Mr. Alexander Shaw, that you were desirous of having some notes which I had taken of a case of partial paralysis of the face, I beg leave to transmit them to you.

"S. Nicholas, æt. 35, a sailor.—He has been ill for upwards of three years, with various scrofulous affections. Two years ago, he first noticed that he was deaf in his left ear. Subsequently there has been a discharge from it. About nine months ago, abscesses formed in various parts of his body, one of which broke just betwixt the mastoid process and the angle of the jaw of the left side. The cicatrix is still painful to the touch. Shortly after the formation of the abscess, it was remarked that the left side of the face was paralysed, and the eye-lids of the same side stood open, and could not be closed by any mental effort directed immediately to them*.

"He says that a portion of that side, viz. the fleshy part of the cheek, feels puffy, although he adds, he is conscious that this is not really the case. The left ala nasi is also paralysed, for if he lies on the right side with his head pressed against the pillow, he is obliged to pull the left nostril open with his fingers in order to breathe freely.

"He also says, that he feels as if he had no power to hold any thing with the *sound* side of his mouth. It is certain that he always applies the mug, in drinking, to the paralysed side.

"He can chew equally well on both sides. And the sensation of touch is equally acute in all parts of his face. The eye-ball of the left or paralysed side is also sensible to touch and to other stimuli. The motions of the eye-ball were examined by Mr. North of Seymour-street, by Dr.

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* It may be worth remarking, that Nicholas always keeps the lids of the left eye closed by his hand, to keep it warm, as he says.

Stewart, Mr. Griffiths, and by myself, and it was evident to all of us, that whenever the patient attempts to close his eyes, the left eye-ball is turned up. When the right eye-ball was examined by forcibly separating the lids of that side, it was always found in the same position as the left. I remain, dear Sir, your obliged,

"R. Ferguson.

"Feb. 21, 1825.
"5, Baker-street, Portman-square."

We have, in the foregoing letter, a simple and very clear statement of a common case. For the case is very common, although the observers are not always masters of the subject like Dr. Ferguson.

The *rationale* is obvious enough. The *portio dura* is involved in the stool of an abscess; and it has partaken of the inflammation. Just as the spinal marrow being involved in the inflammation of the diseased vertebral column will cause paralysis of the lower extremities, so here the muscles of the face corresponding with the *portio dura*, lose their power.

The reader will observe, that the patient "*can chew equally well on both sides.*" I have noticed such circumstances before, that although the individual could not hold his pipe with the lips, he could turn the morsel, which led me to reflect on the muscular branches of the fifth pair sent to the buccinator muscle, and the levator and depressor anguli oris.

Motion of the Eye.

In the preceding letter, as well as in several which follow, notice is taken of the rolling of the eye-ball. I have explained the necessity of a connexion between the motion of the eye-lids and the motions of the eye-ball itself; and I have shown that the connexion between the muscles of the eye-lids and eye-ball is established at the roots of the seventh and fourth nerves. I may be permitted to express my surprise that there has been any doubt upon this subject: it is so easy to prove that when the eye-lids close, the eye-ball rolls up.

In reference to the last letter, it is distinctly stated, that when the eye-lid stood open from paralysis, the eye-ball turned up at every effort to close the eyes. Systematic authors call this want of power to close the eyelid, *Strabismus lagophthalmos; Vue de lièvre,* from the vulgar notion that the hare sleeps with her eyes open.

Sauvages says, that this affection is classed with strabismus; but on what principle, he adds, authors have failed to inform us. I believe it is owing to the eye-ball being seen turned up, which is conceived to be part of the disease; but this is a natural action, which, from the eye-lids being apart, is visible, and appears symptomatic of disease.

On every occasion where the immobility of the eye-lids has given me the opportunity of observing the motions of the eye-ball, it has rolled upwards, as I have described during the effort to close the eye. I have many times pointed out the circumstance to the pupils going round the hospital.

Dr. Brewster, in his Journal, denies that the eye-ball revolves. There can, however, be no doubt of the fact. My reader must perceive the object of the first paper on the motions of the eye, to be, *first,* to show the different motions of the eye-ball and eye-lids, and to deduce from that examination the necessity of two classes of muscles. *Secondly,* to show that the muscles are divided into two classes; that to the motions of the one we are acutely sensible, while to the operations of the other we are totally insensible; and hence to prove that there must be nerves with distinct endowments. *Thirdly,* it is shown, that owing to the different sensibilities enjoyed by the organ, and the distinct classes of muscles, there is a necessity for the six nerves which go to the eye-ball and eye-lids, and this is the final object of the paper. A reader of Dr. Brewster's Journal could not guess at the contents of this paper. I hope the feeling which dictated his observations has subsided.

No. VII.

Case of Partial Paralysis.

"Mary Unwin, now in the twenty-second year of her age, is about seven months advanced in her second pregnancy: she is of a full habit of body, and instead of having the usual wasting of the face and sharpness of features, she has a plumpness and fulness. She has for some time complained of spasms of the lower extremities. Her constipated state of bowels has required powerful purgatives to relieve her. The head has not been the seat of any particular affection, though, when the inquiry was repeated, she observed that there had for some time existed a dulness over the eyes. —She applied for advice respecting a remarkable affection of the face, on the 5th of February. On examining the countenance, a singular distortion of the features is most apparent. The mouth is drawn to the right side, and the nose evidently inclines in the same direction. She was asked to put the forehead in action as in frowning, and then was presented the appearance of wrinkles across the right side of the forehead, whilst the opposite side was even and perfectly unmoved. In sleep, the right eye-lids are closed as usual, but the left eye remains uncovered. She appears to have no power over the muscles, whose office it is to move the eye-lids of the left side.

" There is little (I think no) difference in the sensibility of the two sides of the face. There is occasionally a dimness of vision of the left side, owing probably to the circumstance of the globe of the eye not being lubricated with the tears, as is the case with the opposite one.

" The patient states that she experiences pain on the left side of her neck, and at the root of the ear of that side; but there is no swelling nor marked evidence of inflammation existing in these parts. On pressing on the branch of the *portio dura*, or, as you have termed it, the respiratory nerve of the face, especially in the situation of the parotid gland, no uneasiness is experienced. The iris moves in obedience to the stimuli of light, and the tongue possesses its natural movement. In fact, there is no paralysis in any part of the body, excepting in those parts specified above, and which are supplied with nervous influence by the *portio dura.*

" I have been guided in the treatment of this case by the improvement which your important discoveries has effected in the pathology of partial paralysis. Instead of fearing the supervention of pressure on the brain, I considered the affection as confined entirely to an individual nerve. Formerly, excessive depletion would have been resorted to here: I have adopted moderate evacuation, with local stimuli, &c."

This case was sent, with a very polite note, from Mr. Jackson, of Sheffield. I wrote to him, and this is his answer ;—

"Sheffield, April 23, 1825.

"Dear Sir,—Considerable delay has been occasioned in my replying to your queries respecting the motions of the eye-ball in the case of partial paralysis of the face, which I had the honour of communicating to you. When the patient attempts to close the eye-lids, the upper lid of the right eye obeys the will, whilst the upper lid of the left side remains motionless; and at the same time the left eye-ball rolls upwards, so as nearly (sometimes entirely) to conceal the cornea.

"During sleep, the eyes are similarly circumstanced. The right is closed, and the upper eye-lid on the left side remains as in the state of ordinary vision, whilst the inferior margin only of the cornea is visible; then simulating the appearance, on the paralytic side, of a person in the act of dying.

"During the violent respiratory efforts of labour, the expression and action of the muscles on the left side of the face were lost; in consequence of which, the countenance assumed a singularly ludicrous aspect. I am sorry to add, there appears very little improvement in the state of the patient.

"It affords me great pleasure in having contributed to establish, by a rare and important pathological fact, the truth of some part of your discoveries as connected with the physiology of the nervous system.

"I remain,
"Yours very truly,
"Wm. Jackson."

The manner of this letter must convince my reader how well Mr. Jackson is capable of observing minutely. What I drew from the anatomy is here distinctly stated—that, in sleep, the eye-ball is given to that state of perfect rest where the voluntary muscles are relieved from activity, and the involuntary muscles balanced, and that in this condition the eye is withdrawn from the light.

The agony, that is to say, the seeming agony, of dying, is very naturally touched upon. We cannot visit the sick without witnessing the influence of the obliqui on the expression of the eyes. It is the *Strabismus* *patheticus—orantium* of Boerhaave. Sauvages says, that the eye is turned up towards the close of formidable diseases; "*(Strabismus) paulo ante mortem supervenit.*" The vulgar say, that children with water in the head are looking to their final home, "*Vulgo aiunt hos tenellos suam patriam respicere:*" and on this he adds, wherefore is the superior elevator muscle of the eye convulsed alone, so that the white of the eye only is visible? It passes my understanding: "*ratio me latet.*"

It would indeed be strange if one muscle of a class were thus exerted; but it is not so. The rectus superior is not convulsed; for we have seen, that when that muscle was cut, the eye-ball still turns up, on irritation, by the influence of the obliqui, and that the progress of debility over the voluntary muscles of the eye, as over the other muscles of volition, leaves the obliqui with a relatively greater power, and that it is their operation which distorts the eye-balls.

No. VIII.

Cases of Affections of the Nerves, with Clinical Remarks.

The three following cases were read from the Case-Book of the Middlesex Hospital, at Mr. Bell's Lectures, on the 21st and 23d of January, and were made the subjects of clinical remarks by him. They show, in a very striking manner, the advantages in the formation of our diagnosis, derived from the discoveries of the distinct functions of the nerves of the head. He interspersed the reading of the cases with remarks, which we put down in the order they were made.

CASE I.—Case of Affection of the Nerves of the Head, with Paralysis of the Muscles of the Eye.

John Windsor, lately a farrier in the 2d regiment of horse-guards, came to the Middlesex Hospital in the middle of November, and was placed under Mr. Bell's care. He has lost the power of elevating the left eye-lid, so that it covers the eye, as in the case of ptosis: but his chief suffering arises from a continual and severe pain seated in the left side of his face.

He gives the following history of his illness. He was wounded in the commencement of the battle of Waterloo, by the bursting of a shell which he saw coming towards him. He was struck on the left temple and cheek-bone, and was rendered insensible. He recovered his senses on the second day, and then found himself in the hospital at Brussels. He was soon restored to health; but it was some time before he recovered from an inflammation of the left eye, which had been injured by the mud being thrown into it at the time he was wounded. Five years after receiving this wound, he got a second hurt in the same place, while shoeing a horse: the animal kicked out, and threw him against a wall; his scalp was turned up, and bled profusely. He continued in the regiment, fit for duty, until about a year and a half ago. Previously to this time he had become subject to severe headaches and giddiness. He then had an attack of hemiplegia on the left side. From this he soon recovered; but there was no abatement of the severe pain in the head to which he was subject. "It all rested itself," he said, "in the forehead, and in the left cheek." Four months ago, when the pain was dreadfully severe, so as almost to make him frantic, he suddenly lost the power of opening his left eye; the eye-lid dropped and hung like a curtain over it, thus depriving him of vision in this eye.

Clinical Remark.—"You will recollect, gentlemen, how the eye-lid is moved, and by what nerves. The attollens palpebræ superioris arises along with the recti muscles, and running over the eye-ball and upon the superior rectus, has its tendon spread into the ciliary cartilage. This muscle is supplied by a branch of the third nerve. The orbicularis palpebrarum shuts the eye-lids, and is supplied by a branch of the portio dura of the seventh pair, coming round superficially from before the ear. This falling of the eye-lid, therefore, implies that a disease has affected the third nerve in its course: the power of winking and corrugating the eye-lids remaining, implies that the seventh nerve, by its circuitous course, has escaped that diseased influence."

At the same time it was discovered by the surgeon who attended him that he squinted; when his left eye was exposed it was seen fixed, and looking outwards. It remained in this position for ten or twelve days; but afterwards it came gradually to be directed forwards.

"This circumstance would imply, that whilst the muscles of the eye were paralysed by the pressure on the third nerve, the abducens, or sixth nerve, had for a time escaped; but that the disease at length encroached upon the sixth, and consequently paralysed the rectus externus, and thus reduced all the muscles of the eye to the same condition."

The upper lid of the left eye completely covers the eye-ball. When asked to try to raise it, he arches the eye-brow, but produces no effect on the eye-lid. He can wink, and shut this eye forcibly. When the eye-lid was raised with the finger, and he was asked to look around in various directions, it was found that he had no power of moving this eye either sideways, or upwards, or downwards; but, whilst the right eye was revolving from one side to the other, this remained perfectly stationary. When the eye-lids were again held apart, and he was told to wink, still the eye-ball continued fixed.

"You know the eye-ball is turned up by two different muscles. If you direct your eye upwards to look at an object, the rectus superior and attollens palpebræ combine together, and both the eye-ball and eye-lid are raised. If there were not such a combination between these two muscles, the eye-ball might be turned up by the effort of the rectus, but instead of seeing by this means, the pupil would be turned under the eye-lid. Again, when the eye-lids are opened by the fingers, and held apart, and the person is asked to shut them, you see the eye-ball roll up. Here the rolling up of the eye-ball, combined with the action of shutting the eye-lids, is not performed by the same muscle which turns the eye-ball up in vision. This motion is involuntary, and is performed by the inferior oblique muscle. But this, as well as all the other motions of the eye, are in this case gone, which shows that all the nerves of the muscles within the orbit are affected."

Although he has lost the motions of this eye, still he retains vision in it. This is slightly obscured by a nebula upon one side of the cornea;

but which has been the same ever since he had inflammation of the eye consequent on the wound received at Waterloo. The pupil of the left eye is dilated considerably more than that of the right eye, without any irregularity of its shape. Upon a careful examination, not the slightest motion of the iris could be perceived in the left eye. He can distinguish light from darkness through the eye-lid. He complained of the candle-light giving him uneasiness.

"When you simply close the eyes, but are awake to all that is going on about you, you see the light through the eye-lid: the eye-ball does not turn up. But when the eye is closed in sleep, the eye-ball does turn up, the pupil is directed upwards, and the light, coming through the eye-lid, is a less annoyance. In this case, as in others which I have seen, the axis of the eye remaining in its usual place, although the eye-lid be dropped, the patient complains of the light of the candle in the ward.

"You will further observe, in what has been read, that the iris is insensible to the variations of light. This reminds you, that the relation established between the retina and iris is not direct,—is not in the organ; but the impression must be carried back to the sensorium through the optic nerve, and return again through the third nerve. Therefore, by the influence of the third nerve being destroyed, we see why the motion of the iris should be arrested."

The surface of the eye is quite insensible to touch. When we held up the eye-lid, and threatened to touch the eye, he drew back and winked before the finger had touched him; but when the finger was drawn across the eye-ball, he did not feel it. This eye is equally bedewed with moisture as the other. There was not observed to be any increased flow of tears after touching it. This eye is a little more prominent than the right one.

"You will observe these circumstances with interest. When he saw you aiming, as it were, to injure the eye, he winked, because the vision was perfect, and the motion of the orbicularis palpebrarum remained: the circle between the retina, brain, and the muscle, being entire. But this was not the case when you touched the eye. On touching the eye, the impression should be upon the fifth nerve; but the fifth having lost its function, there was no impression carried backwards to the brain, and of course none was given to the portio dura of the seventh, to bring the orbicularis into action."

His reason for applying for relief is not so much on account of this condition of the eye, as that he suffers such excruciating pain in the left side of his face. His appearance shows how harassed he is with long continued suffering. The pain extends over all the left half of his face, and he points to the forehead, the cheek above the angle of the mouth, the chin, and the side of the tongue and the gums, as the parts principally affected. It is a dull aching pain; but in the side of the tongue it is rather of a burning kind. All these parts are much deadened in their sensibility, but more so in some parts than in others. Thus sensation seems altogether gone upon the side of the forehead, and we may rub the surface of the eye with the finger without his feeling it; while, in the other parts of the face, he can merely, in an imperfect way, distinguish whether we touch him or no. On tickling the orifice of the left nostril with a feather, he made no signs of this annoying him; but he started back and pushed the feather away whenever it was put to the right one.

" I must remind you, that upon an injury to a nerve any where in its course, the pain is referred to the extremity of that nerve. If we could imagine, as is most probable in the present case, that a tumor or abscess engages the root of the nerve, then there would be pain, not in that part, but referred to the extremities of the nerve. This, perhaps, accounts for the pain in the corresponding side of the face and of the tongue. And you will observe at the same time, that it is quite consistent with this opinion, that the parts, which are the seat of this morbid pain, should still be insensible when touched: for the disturbance in the root of the nerve which causes the false impression of pain in the extremities of it, prevents the course of sensation being conveyed from the surface towards the sensorium."

As it appeared that there was here an affection of the trigeminus, or fifth pair of nerves on the left side, we were led to examine the condition of the temporal and masseter muscles. He was directed to open and shut his mouth, and clinch his teeth firmly together; and while he did this, the fingers being placed first upon the two temporal muscles, and then upon the two masseter muscles, the comparative degree of action in them was observed. It was distinctly perceived by all who examined them, that while the muscles on the right side bulged out and contracted naturally, those upon the left side were quiescent. The masseter on the left side was wasted and flaccid, so that the surface of the jaw-bone could be easily felt. The corresponding muscle on the right side was hard and full.

" You will remember, in the demonstration of the fifth pair of nerves, that it bore an accurate resemblance to the spinal nerves; that the anterior root passed the ganglion on the posterior root, and went to the muscles of the jaws; so that this nerve, like the spinal nerves, possesses a double function. If, therefore, a disease affects the roots of this nerve, we should expect, what is here stated, that at the same time the sensibility of the face was diminished, the muscles of the jaws should be weakened."

The temperature of the skin on both sides of the face appeared to the touch quite the same. He was ordered to have six leeches applied every third day behind the left ear; to take a Plummer's pill every night; his bowels to be kept open with salts and senna; to rub the back of his neck with the camphorated mercurial liniment, and the lotion of lead and opium to be applied to the left side of his face.

Dec. 24th.—He has attended as an out-patient, and has expressed himself somewhat relieved by the treatment. But to-day he complains of being much worse: the pain in the side of his face is more severe; he has almost entirely lost vision in the left eye, and yet the eye is quite transparent: this has come on gradually since yesterday, and has not been attended with flashings of light. He is also deaf in the left ear, but this symptom has been coming on during the last week.

Dec. 29th.—This man was admitted into the hospital on the 24th, but he left it late on the same night, and returned home. Being visited at his house, he said that the patients in the ward had complained of the noises he made while trying to blow his nose, and therefore he left the hospital. He has formerly complained of an obstruction to his breathing at the back part of his nostrils. He sometimes starts up in bed with a sensation as if he were choking, and makes strong efforts, by sneezing, hacking, and blowing his nose, to remove something which seems to block up the posterior nares: he also made use of a bit of wood, which he thrust into his back nostrils on the left side, and picked away pieces of a substance resembling glue, tinged with blood.

" I presume nothing can more convince you of the insensibility of the surfaces resulting from the disorder of the fifth nerve than this practice of the poor man. He is tickled with a feather on the right nostril, and yet on the left he thrusts back a rough stick into the cavities of his nose."

This difficulty of breathing was much aggravated on the day he was admitted into the hospital.

On the night of the 26th he was extremely ill; suffering very great pain in the forehead, having a succession of cold fits, and no sleep. In the morning his wife was alarmed by finding his face twisted to the right side; and she immediately went to obtain medical assistance at a neighbouring dispensary. He was cupped at the back of his head, and afterwards a large blister was applied.

The muscles on the left side of his face are paralysed. The eye-lid can now neither be elevated nor shut: it remains in whatever position it is put by the finger, being like that of a dead person. There is great redness and turgescence of the conjunctiva, and there is a film, as if it were dried mucus, covering the greater part of the surface of the eye. The patient said he had picked some of this off with his nail. He was cautioned against repeating this, and his wife was instructed to bathe the eye frequently, and to cover it with its eyelid. When the face became paralysed the pain was considerably abated, and now he suffers comparatively little from it; the sensibility to touch is still defective as before.

" In these circumstances we have a proof of two properties of the nerves being necessary to the preservation of the eye. The sensibility to impression is followed by the winking or closing motion of the eye-lids, which washes off or otherwise removes the offending body. There was danger to the organ when its guardian, the sensibility, was destroyed; but when, at length, the winking motions were lost, and the tension of the orbicularis muscle, which supports the eye, gone, then a destructive inflammation very quickly followed. And you have here, in this case, as you may have also seen lately in a patient in the cancer ward, the very singular phenomenon of a person picking the inflammatory crust from the surface of the eye.

" I may here make a clumsy comparison to illustrate this subject, and yet I believe the analogy is perfectly correct: Formerly, in speaking to you of the fractured spine, with the loss of sensibility in the hips and the lower extremities, I told you that it was necessary to direct the nurse to shift the patient a little, from time to time, and to support him with pillows, put under the loins, hips, and thighs, otherwise your patient would soon have mortification of the hips. Consider how often you have shifted your seats since you have taken your places before me this evening —that irksomeness which makes you change the pressure from one hip to the other is the guard upon the texture of the part, and if you had not that uneasiness, you would have worse when you rose up—you would have actual pain, followed by inflammation. But if a person, who has the spinal marrow torn across, have no such shifting motions, no little accommodation of posture so as to throw the pressure upon different parts, then you know the consequence is that, being neglected, he has mortification of the hips or heels. Thus we understand the necessity of pain or uneasiness, as a continual monitor to us; and we see in the eye what is the effect of the loss of this sensibility, that it inflames, loses its transparency, and is finally destroyed."

He can twist his tongue about: he has no numbness nor loss of motion in his extremities, and his intellect is perfectly clear.

Dec. 31st.—His hearing has now returned to the left ear: the pain in his face is less.

Jan. 14th, 1829.—He returned to the hospital to-day. He has now regained the power of motion in the muscles of his face to a certain degree, but not perfectly: his eye may now be said to be completely lost: the conjunctiva is of a bright red colour, and the cornea projects like a horn, being apparently about to slough. The pain which was so severe in the forehead, is now entirely gone. He complains more of pain in the back of his head. A seton has been put in the back of his neck.

Jan. 29th. The cornea has sloughed, and a part of the humours, of a dark pulpy appearance, projects from the centre of the eye: when he presses the eye, it bleeds. He is much better in other respects.

May. This man progressively improved, and he attributed his relief to the seton placed in the back of his neck. His eye-ball was found one morning to be turned inwards, and it remained permanently so. It became clearer, but he never recovered vision in it. By degrees the sensation returned to the skin, and the pain in his face entirely ceased. The action of the muscles of the jaws could again be felt when he chewed.

No. IX.

Case II.—Notes of the Case of a Patient who had Paralysis of the Muscles within the Orbit.

Geo. Bungay, æt. 20, was admitted, under Dr. Macmichael's care, Nov. 22d. He had symptoms of fever for a week before he presented himself at the hospital. He complained of getting no rest at night: his bowels were constipated; his tongue foul; the pulse slow and regular; he had slight tenderness in the epigastrium; he suffered no pain in the head. On the night of the 23d the nurse said he wandered a little in the night. On the following night he had no rest. In the afternoon of the 25th he was seized with delirium; the delirium came on in paroxysms. After this he fell into a comatose state. He continued in this state until his death, which happened on the 29th.

When the delirium came on, it was observed that the right eye remained always closed, while the left eye was opened: he had lost the power of raising the lid of the right eye. Upon elevating it with the finger, it was discovered that he had also lost all motion of the eye-ball: while the left eye revolved from one side to the other, this remained still, and as if he were looking straight forwards. On holding the eye-lids apart, he resisted with the orbicular muscle, and closed them again forcibly together.

Dissection.—There was a considerable quantity of serum in the ventricles of the brain. On raising the brain from the basis of the skull, both the optic nerves, but in particular the right one, were observed to be more vascular than natural. On dividing these across, and continuing to turn back the brain, it did not separate easily as usual. There was found to be a thick deposit of coagulable lymph, straw-coloured, and of the consistence of jelly, which caused the upper part of the pons varolii to adhere to the dura mater. This was most abundant on the right side of the sella turcica. All those nerves which passed into the orbit were enveloped in this deposit: the third pair of nerves was completely embedded in it, and had a yellowish brown appearance. The corresponding nerves upon the left side were also affected, but in a slight degree. On examining the roots of the portio dura of the seventh pair, they were found quite removed from the disease.

"You will in this case distinguish the symptoms of delirium and coma from the local affection; and as regards the appearances on dissection, you will also distinguish the result of the general condition of the brain from the more local effects upon the base. The effusion into the ventricles of the brain shows the state of general excitement; but it is to the coagulable lymph matting the third, fourth, fifth, and sixth nerves together, that you must look for an explanation of the symptoms in regard to the condition of the eye. The root of the seventh pair being free from the disease, explains how the eye-lids retained their winking motions, whilst the eye-ball was stationary from the disorder affecting the third, fourth, and sixth nerves.

"If I brought to you my private cases of consultation, you might suppose that, owing to circumstances, cases of diseased nerves were accumulated; but you now perceive, in the common practice of an hospital, how frequent these cases of nervous affection are; and the interest you attach to them, proves to me the advantage of an accurate knowledge of the anatomy in exciting minute attention to symptoms, and satisfactorily explaining them. If you had not known the distinct uses of the fifth and seventh pairs of nerves, you would have had no gratification in following these details."

No. X.

Case III.—*Case of Partial Paralysis of the Face.*

James Delahay, æt. 13, Nov. 26.—Seventeen days ago he fell from a scaffolding ten feet in height, and was brought to the hospital immediately after the accident, suffering from the effects of concussion. There was general tumefaction of the left side of his head, from the jugum to the vertex, and there was a bruise of the scalp above the ear, marking the place on which he had fallen. He recovered his senses about an hour after the accident. His head was shaved, leeches and cold lotions were applied to it, and he took purgative medicines. At the end of a week he was so far recovered as to be dismissed from the hospital. He continued in good health until Sunday last, when he had a severe headache, which went off in the course of the day. On Monday his friends were alarmed by observing his face twisted to one side; they therefore sent him to the hospital, and he became a patient of Mr. Bell.

The left side of his face is relaxed, and the natural balance of the features is gone, so that the countenance has a distorted, wry appearance.

"You have so lately had a demonstration of the nerves of the head, that I need hardly remind you that all the motions of the face,—the motions of the forehead, of the eye-lids, the nostrils, the expression of the cheek and lips, both in passion and in speech, result from the influence of the portio dura of the seventh pair; and that the muscular branches of the fifth pair are given to parts internal, and to such as have no direct connexion with the actions of respiration. The debility or disorder of the portio dura has the most unhappy consequences upon the countenance: when this nerve has lost its power, the corresponding side of the face becomes immoveable as a mask, or it is drawn to the opposite side by the excited action of the muscles there. It is important in your practice to observe the different causes of this defect: the slightest, perhaps, is an influence on the surface; the next is a swelling of a gland, in the course of the nerve, which presses upon it; the third is a suppuration within the ear; the fourth is a suppuration at the basis of the brain; and, lastly, the defect may arise from neither of all these, but from the condition of the brain itself, and may be in correspondence with the paralysis of the other motor nerves. In the present case, the boy received a violent injury on the same side of the head on which the paralysis is; and we have had cases in the hospital where the portio dura was torn by the fracture passing through the temporal bone*; but in the present instance this could hardly be the case—the paralysis would have taken place at once, whereas it has come on at a later period, and has been accompanied with swellings of the glands of the neck, and with no defect of hearing on that side.

"When we see a person alarmed without cause, and there is no danger in the case, there is something approaching to the ludicrous in the scene. A physician paid me a visit who had come up from the country in the mail, and had fallen asleep in the night-time, with his cheek exposed at the open window to the east wind. On the morning of his arrival, when preparing to go abroad, he found, upon looking into his glass, that his face was all twisted. His alarm gave more expression to one side of his face, and produced more horrible distortion. Both laughing and crying, you know, depend on the function of this nerve, but when he came to me he considered it no laughing matter: I never saw distortion more complete. It was difficult to comfort him; but I am happy to add, that the paralysis gradually left him, as I told him it would. I have at present a young lady under my care who has paralysis of the face, and who has received great benefit from galvanism. And I have lately seen an instance of the same kind; the more remarkable only as showing how the want of expression will injure the finest countenance. I mention these things to remind you of the frequency of the occurrence, and of the necessity of your distinguishing the slighter cases, where the exterior branches of the nerve are affected, from those wherein the cause is deeper seated, and more formidable."

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* No. XI.—A man was brought into the hospital who had fallen from a height upon his head. He recovered from the first shock of the accident; but he continued in a dull stupified state, complaining much of headache, for a week, when he became comatose, and died. He had paralysis of the muscles of the left side of his face. What was chiefly remarkable, there was a constant flow of clear serum from the left ear, so that the concha was always full of it, and the pillow commonly wet. On dissection there was found a fracture extending across the basis of the skull, and passing through the petrous portion of the left temporal bone, tearing the seventh pair of nerves just at its entrance into the meatus auditorius internus. The dura mater was torn where it passes from the sella turcica to the petrous portion of the temporal bone; and the cavernous sinus was found infiltrated with serum. There was a considerable effusion of serum between the dura mater and the brain. A communication had been formed through the laceration of the dura mater, and the fissures in the temporal bone, by which this serum had flowed, during life, first into the cavities of the ear, and thence it had escaped outwards through a rupture of the membrane of the tympanum.

The left eye stares widely and unnaturally open, while the right is only moderately disclosed; when he makes an attempt to close the eye-lids, the left remain unmoved; but the eye-ball is elevated upwards; and it is raised to so great an extent, that the pupil is quite concealed beneath the upper lid, the white of the eye only being exposed. He is unconscious of the eye-ball thus revolving upwards: the objects around him in the ward are not seen at all while it takes place. He was told to direct his eye so as to look as straight above him at the ceiling as he could: when he did this, it was observed that he could not raise the pupil, by his utmost efforts, so high, by some degrees, as during the involuntary act. When turned up in the effort to wink, the cornea rose so as to be presented towards the roof of the bony orbit, and consequently quite concealed by the eye-lid; on the other hand, when he looked upwards at the ceiling, more than one-half of the pupil remained visible. During sleep the eye-lids remain wide open; and the pupil is concealed, just as it is observed to be when he winks. It is remarked that the globe of the eye protrudes considerably more than the other; the conjunctiva is inflamed, and is loaded with numerous blood-vessels. He says that he suffers pain from this eye being constantly open, especially when he is sitting before the fire at night.

"I am sure you have listened with interest to the statement of these facts, which you can yourselves verify; and, first, as to the protrusion of the eye. Any one ignorant of the functions of the nerves, looking upon this boy, and observing the defect of the eye-lids, and the protrusion of the eye, would say that there must be some tumour in the orbit forcing out the eye; and this they would, no doubt, also consider was the cause of the debility in the muscle. But by a more correct process of reasoning you perceive that the defect is solely in the portio dura of the seventh pair. The eye-ball is naturally held between the muscles within the orbit, and the orbicularis muscle without; but in this case the exterior muscle, viz. the orbicularis palpebrarum, has not only lost its activity, but its tone; and the greatest difference may be perceived between the right and left eye-lids by pinching them up with the finger and thumb. There is thus a want of pressure exteriorly, which permits the muscles within the orbit to press the eye-ball out, and is the reason of the prominence of the eye. Indeed, this want of support may, in part, conduce to the inflammation and debility of the eye, which result in those cases where there is a defect of muscular action.

"I shall direct your attention to one more circumstance only in the narrative; viz. the difference of the extent of motion when the pupil is directed upwards by volition, and when it is turned up by the instinctive and involuntary actions of the muscles. I think I formerly told you that on cutting the superior rectus in the monkey, the animal lost the power of directing that eye upwards; but when the eye was stimulated by the end of a feather, and the effort to wink or close the eye was produced, the eye-ball turned up, and the pupil was concealed under the eye-lid. Such an experiment, I think, satisfactorily proves that the superior rectus is the voluntary muscle, and the inferior oblique the involuntary muscle to turn up the eye-ball. To suppose that the eye is revolved upwards by the superior rectus when the eye-lids are closed, would be to make this muscle act at the same time with the contraction of the attollens palpebræ superioris, and act also at the moment of its relaxation. Thus, when you look upwards to the ceiling, you elevate the eye-lid at the same time that you raise the eye; you perform the motion of the eye-ball with the superior rectus, in conjunction with the attollens palpebræ superioris. If there were not this sympathy between these two muscles, the eye-lid would not be raised in proportion as the eye-ball was turned up, and no advantage would be derived from the revolving of the eye-ball, since the pupil would be turned under the eye-lid. You see, then, there must be a strict sympathy in the contraction of these two muscles. But we have another action in the eye-ball to provide for—a rolling upwards of the eye-ball while the eye-lids are closed, as in winking and in sleep. Now to suppose that the eye-ball was in this instance also rolled upwards by the rectus, would be to make it act both with the contraction and with the relaxation of the attollens palpebræ. Thus by reasoning, as by experiment, we come to the conclusion that the instinctive rolling up of the eye-ball, as in winking, is not produced by the action of the superior rectus, but by the inferior oblique muscle.

" In this youth the motions of the eye-ball, in its different conditions, can be well observed, owing to the eye-lids remaining open: for example, we ascertain that the eye-ball turns up when the effort is made to close the eye-lids. With regard to this motion, it is curious to observe that here, as in many other instances, part only of the action is voluntary and sensible—viz. the closing of the eye-lids; whilst the other part, the revolving of the eye-ball, is insensible. We have an opportunity of further observing, as the narrative proceeds, that in the voluntary direction of the eye upwards, the action is limited; indeed we may say, what would be the use of that muscle (which is to direct the axis of the eye in vision) carrying the centre of the cornea higher than the margin of the orbit, and under the upper eye-lid? But we do see a reason why the obliquus, in the involuntary motion of the eye, should carry the cornea much higher up, since the object is to moisten it at the fountain of the tears, and to purify it from all irritating matter. Accordingly, when this youth's eye is irritated, and the involuntary muscle brought into activity, the eye-ball is revolved so much, that the cornea is quite lost under the eye-lid."

When he is told to frown there is no motion perceived on the left side of his forehead, but all the expression seems drawn to the right side. When made to laugh, the features are curled up in the expression of laughter only on the right side of his face, which presents a singular contrast with the sad, or rather lifeless appearance of the left or paralysed side. When a spoon was put into the left angle of his mouth, he could not grasp it; he said that in eating he put the morsel into the right side. The left nostril is not dilated in a corresponding degree with the right; and the difference between them was most distinctly seen when he attempted to sniff up the air or to breathe hard, for then, whilst the right nostril expanded more widely, this one became quite collapsed, or shut up against the air.

The sensibility of the skin over the whole of the head is perfect, and the muscles of the jaws act powerfully. He can move his tongue about in all directions.

There is a greater fulness over the left temple and jugum than over the right; there is also a blueness of the integuments, consequent on the injury which he received, but he does not even wince if this part be pressed severely. There is an enlarged gland in the hollow under the left angle of the jaw, and it gives him pain when pressed. The whole chain of the glandulæ concatenatæ in the left side of the neck are enlarged and tender. His hearing is not affected, and there has been no discharge from the ear.

He says that for some days his head has been drawn towards the right side; but this symptom has disappeared, and he can hold his head erect.

> Leeches to be applied before the ear; the face to be rubbed with the camphor liniment; cold lotions to be applied to the side of the head; and a powder of Calomel gr. iv. Rhei gr. viii. to be taken twice a week. He was instructed to move the eye-lid with his finger over the eye frequently, so as to lubricate its surface.

Nov. 29th.—His head is twisted to the right side, and this is the position in which he said it had formerly been. The head is not merely inclined to the right, but it is also twisted round, so that the right ear presents forwards. On examining the sterno-cleido mastoideus muscle upon the right side, it is found hard and tense, being in a state of *tonic spasm:* it is the constant action and rigidity of this muscle which prevents the head from being moved to the erect position. It gives him no pain. When he is asked to hold up his head, he throws his head back, but still the neck is twisted towards the right: he can rotate his head in various ways to the right side and to the left, yet he is always checked by the permanent contraction of the sterno-mastoid muscle alone.

Dec. 2d.—This boy has continued in the same state as has been described above; but to-day the spasm of the sterno-cleido mastoid muscle is considerably diminished. He has rubbed the neck with the camphorated mercurial liniment.

Dec. 5th.—He can now hold his head erect, and move it easily in any direction.

Dec. 20th.—Little change has occurred since the last report. The contraction of one side of the neck has not returned. He complained at one time of having some difficulty in swallowing; but nothing could be observed on inspecting the inside of his throat. His face is now in a great measure restored to its natural balance, at least it appears so, if we look at him when his countenance is unmoved; but when he begins to speak or to smile, then the distortion is visible. Leeches have been applied in succession under the angle of the jaw; he has regularly fomented the side of his face, by holding it over the steams of the poppy fomentation. A blister is now applied under the ear; he has been taking the infusion of gentian with the carbonate of soda.

Jan. 13th.—He has continued much in the same condition, but he is gradually acquiring some more power in the muscles of the face. The swelling under the angle of the jaw is still of a considerable size.

Mr. Bell here observed that he would not stop to inquire into the affections of the sterno-cleido mastoideus muscle; but he could assure them that it was subject in a particular manner to derangements of this kind; which, indeed, appeared in the cases kept in the hospital book[*].

No. XII.

Case of Paralysis of the Voluntary Muscles of the Eye-ball.

(Communicated to the Author.)

"November 24, 1825.

" The master of a small trading vessel applied for advice. The most prominent and obvious symptom of the case was *Ptosis*, or paralysis of the upper eye-lid. Suspecting that there might be a general affection of the third nerve, or motor nerve, I desired him to look to the ground: he attempted it, but was utterly unable to accomplish his intention. He was also told to look upwards, and then inwards: in both which he failed.

" He could close and wink with the eye-lids when we touched the cilia, proving that the *portio dura*, and the branches of the fifth, possessed their sensibility and power[†].

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[*] See the Cases of Spasmodic Affections of the Sterno-cleido-mastoideus muscle.

[†] See the last paper, On the Nervous Circle, reprinted from the Philosophical Transactions.

"Now, forcibly separating the eye-lids, and desiring him to close them, while I still held them open, I could distinctly see the eye-ball turn upwards, which I supposed to indicate that the fourth nerve still influenced the trochlearis muscle.

"He had the power of looking outwards, accomplished by the sixth, which was not included in the paralytic affection. He saw well, save that the fallen lid interfered with vision. He had been troubled with this affection nearly a fortnight, attended with slight headache, and some symptoms of derangement of the stomach and bowels.

"SAMUEL JOHN STRATFORD."

Ptosis is the term applied by surgical writers to the relaxed eye-lid, when the person cannot raise the eye-lid so as to disclose the pupil. We have here nothing to do with those cases, where the inability depends on disease in the eye-lid itself: but it must be acknowledged, that the subject of paralysis of the eye-lid was obscure until these observations were made. We perceive that this ingenious gentleman, when he found that the patient could not raise his upper eye-lid, reflected that this must be from paralysis of the levator palpebræ superioris; that the defect must in all probability be in the third nerve; that if so, the motions of the recti, with the exception of the abducens, must also be imperfect. He found this to be the case. He then reflected that the instinctive turning up of the eye-ball depended on other muscles and on other nerves. He knew that when I had cut the voluntary muscle, the *rectus superior*, although the creature could not turn his eye to objects above, yet, that the instinctive motion of the eye-ball upwards by the *obliqui* remained. He tried, and found that the involuntary turning motion of the eye-ball was here entire.

We perceive the importance of this observation, since the defect is proved to be in a cerebral nerve, and therefore to imply an affection of the brain, and to threaten apoplexy. It stands contrasted with that inability of closing the eye which results from the affection of another nerve and of a different system, the system of respiratory nerves, which are more subject to derangement than the cerebral nerves, and which offer a less alarming symptom.

It is said by surgical writers, that where there is *ptosis*, the patient, seeing a little under the eye-lid, soon gets into the habit of squinting. Squinting is never a *habit*, the fact being, that the weakness of the *levator* arises from a defect of the nerve common to that muscle, and to all the voluntary muscles of the eye; and hence the involuntary muscles acquire a preponderance, or comparative increase of power, and drag the eye-ball.

Practice or experience points out a distinction between the condition of the patient, when the eye-lid has fallen from paralysis, and when it is spasmodically twitched by the action of the orbicularis. This last is the periodical ptosis; and do we not perceive that the one is the formidable affection of the cerebral nerve, and the other the sympathetic affection of the respiratory nerve?

The following note, which I owe to our ingenious house-surgeon, Mr. Goss*, refers to a tremulous motion in the muscles of the eye:—

No. XIII.

Incessant Motion of the Eye.

“ Joseph Rogers, 35 years of age, has lost the right eye, and has had an opacity in the centre of the cornea of the left eye for twenty years. The left eye has a curious semirotatory and involuntary motion, which is constant. The rotatory motion is to the extent of about one-fourth the circumference of the ball. The cornea is nearer the nose than is natural, forming an imperfect squint. He has not the slightest power in arresting this motion; it is that which would be produced by the alternate action of the obliqui antagonizing each other.”

I had put my young friends in the hospital upon investigating this case. But being a physician’s patient, and they not knowing my wish, he was dismissed. When the pupils brought me to visit this man, they announced it as a case where, notwithstanding the continual motion of the eye, the patient was insensible to that motion, and saw objects naturally and at rest.

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* Now Surgeon at Dawlish.

Was this a defect arising from the disorder of nerves, or an accommodated action to the opacity of the centre of the cornea?

No. XIV.

Case communicated by Mr. Alexander Shaw.

Sophia Walker, æt. 17, has an incessant motion in both her eyes. The left eye is shrunk; she lost it during infancy, when she had the small-pox. In the right eye there is a leucomatous spot upon the inner side of the cornea, nearly opposite the pupil, and to this part the iris adheres, but she sees objects distinctly with it. The remarkable circumstance is, that her eyes are not for a moment at rest, and yet this motion does not disturb her vision. There is a constant tremulous motion in them, which her mother says has continued since her infancy; it is not so much upwards and downwards, as in a transverse direction, but it is irregular in this respect. When she was requested to take her book and read, she read with perfect ease, and yet there was no cessation of the motion in her eye. She threaded her needle without any apparent difficulty, and then showed how she could sew, which was with the usual nimbleness; she gained her living, indeed, by her needle-work. She also looked steadily at various objects in the room, but the motion of her eye continued the same in all these attempts. She was asked to look as far upwards as her eye could be directed, and in the same manner to strain her eye in all the various directions, but by no means could the tremulous motion be arrested. She was not sensible of there being any defect of this kind in her eye, or at least it did not produce any inconvenience; all objects seemed in their natural state either of rest or of motion. When she looked at herself in the glass, she saw her eye rapidly moving.

In order to ascertain whether any change took place while the eye-ball was involuntarily rolled upwards, the eye-lids were held apart, and she was told to wink forcibly: the cornea was elevated, so as almost to be hid, and during the time that it remained in that position it was quite fixed and steady. It was next desirable to know whether the eye-ball remained fixed during sleep. When the eye-lids were gently closed, the eye-ball continued in a state of motion, and communicated a very distinct quivering to the eye-lids. This was observed by the mother, and she was then requested to take an opportunity while her daughter was sleeping to remark whether this quivering motion continued the same. Three days afterwards I was informed by the mother that no motion whatever could be observed either in the eye-lids or the eye itself during sleep.

No. XV.

Note.—A child, about four years old, was brought to the hospital by the mother, who was a patient. The eyes were observed to roll continually in all different directions, and without any correspondence. It appeared, sometimes, that the child merely squinted, but the squint was continually varying; the motion of the eyes was generally in a transverse direction, but occasionally they converged, and then again separated. The child was very short-sighted, and, it was remarked, whenever any object was brought so close as to attract its attention, that the eyes became fixed. This wandering of the eye resembled what is seen in congenital cataract.

No. XVI.

Note.—June 1st. There is at present in the hospital a young woman who has had cataracts in both her eyes from infancy. She has a constant rolling of the eyes, a vacillating motion, like the balance wheel of a watch. She sees a little, and can distinguish a person in the ward; but notwithstanding the motion of the eyes, the object she distinguishes is at rest.

June 24th.—The opaque lens of the left eye was pierced and disturbed with the needle, and the capsule burst or torn. This operation after three weeks was a second time performed: the vision improved, and the eye became steadier. Some time after I couched the other eye; the vision is perfect in that which was first operated upon, and is fast improving in the second. The motions of the eyes have much diminished.

No. XVII.

Case communicated by Mr. North.

Francis Robbins, æt. 19, has been short-sighted from his infancy. The structure of the eyes appears perfectly natural. The pupils are less contracted by the application of a strong light than is usual. I have seen him frequently during the last six or seven years, and have always observed that the eye-balls are in constant motion, not upwards and downwards, but laterally. He is of a very nervous temperament, and upon the slightest excitement this motion of the eyes is considerably increased, and no effort to look steadily at an object placed before him has any effect in restraining it. His vision does not deceive him as to the state of things he looks at: he is sensible when objects are perfectly at rest, and perceives immediately the true direction of the slightest motion which is given to them: he can read music with facility, and plays accurately from the notes rapid passages on the violin. If he is surrounded by many moving objects his vision becomes confused, and he forms an erroneous judgment as to their distance from each other, and from himself. Thus, in the morning early, before the streets are crowded, he drives a carriage and pair of horses with safety and dexterity, but he cannot do this in the middle of the day, when, to use his own expression, "he gets flustered," and is afraid of meeting with accidents.

¶ This motion of the eye, without a corresponding idea of change in the position of the object, is certainly a very curious fact; yet it admits of explanation, if the statement which is made in the text be correct. We observed that vision is a compound operation, that the impression upon the retina is combined with a certain effort of volition, and that this volition, directed to the muscles of the eye, is necessary to the idea of motion or place of the object. If a motion of the eye takes place without volition, there is a want of that essential circumstance which indicates place or motion. These patients, therefore, having the motion of the eye from a different cause than volition, although the impression of the object moved upon the field of the retina, had simply the sensation on the retina, without the idea of motion, because there was no muscular effort.

Of the Eye-lids; as indicating different Affections of the Nerves.

(A Communication of the Author to the Medical Gazette.)

My attention having been drawn to the actions of the muscles of the eye, I have persuaded myself that there is a strict correspondence between the retina, as the organ of vision, and the surrounding muscles. We observe that, when the retina is excited by vision, there is an attendant excitement of the recti, or voluntary muscles of the eye; and that when vision is not exercised, the eye then becomes passive, and is drawn upwards by the preponderating influence of the obliqui: that, consequently, there is an established relation between the falling of the eye-lid and the revolving of the cornea upwards.

It did not occur to me that any thing farther could be done in the way of experiment, than what is offered in the *Philosophical Transactions*, June, 1823; and I concluded that we must wait for the opportunity of observation in the human eye, to perfect our knowledge of this subject. It is with this view that I present you with the following cases, to which my attention is at this moment directed.

The condition of the eye-lid and eye-ball, when carefully observed, appears to me to give the symptoms of very different affections of the nervous system. Putting aside the affections which come under the head of strabismus, we have, in the first place, the eye-lid fallen, from disease of the eye-lid itself, independent of nervous disorder; secondly, the eye-lid permanently elevated, and the cornea exposed *(Lagopthalmos: vue de lièvre)*, indicating defect in the office of the portio dura; thirdly, incapacity to raise the eye-lid, attended with total insensibility of the surface of the eye and side of the face, with the power of forcibly closing the eyes still retained: indicating disorder of the nerves within the orbit, probably pressure between the origin and distribution of the nerves, the portio dura being free from disease; fourthly, a motion in the eye-ball itself rapidly to and fro *(Nystagmus bulbi)*, independent of any affection of the eye-lid; fifthly, we have the eye-lid depressed, and the motion of the eye-ball remaining; sixthly, we have the eye-lid depressed, and, at the same time, the cornea elevated.

It is to these two latter cases that I have to request the attention of your readers: in the first place, as they imply very different conditions of the nervous system; and, being attended with blindness, may be confounded with affections of the optic nerve or retina.

No. XVIII.

Case of Periodical Blindness, from a Cause not hitherto observed.

The subject of this case is a young lady, twenty-four years of age, of delicate frame, with great intelligence and expression; accomplished, and, as ladies are, studious. She was in the habit of drawing a great deal, and had painted a miniature a short time before the symptoms I have to describe commenced. In giving the case, I am assisted by the letter of her physician, which she presented to me, and which shows that he has studied the symptoms, having that interest in the case which is so naturally excited in a benevolent mind.

In August, 1826, she began to have headaches, which, however, had not a common character: the pain extended down the side of her face to the angle of the jaw, and then backwards into the ear, with a sensation of tightness in the skin of the forehead; and this pain she had first on one and then on the other side of her face. These pains appeared to her physician to be " connected with considerable disorder of her stomach and alimentary canal, increased, if not produced, by too sedentary a habit, and application to drawing. After a dose of calomel and opium, she took, in succession, the sulphate of quinine, the extract of henbane, and the liquor arsenicalis. She had also the blue pill, until her mouth became a little sore."

The pain had ceased, and a " heavy stupidness," to use her own expression, prevailed for a few days, when one day, in reading, she found that she could not see the letters,—they were thrown together and confounded. This obscurity of vision was attended with a fluttering in the eyes, which seemed to her alternately to open and shut with great rapidity: by turning away from her book and attending to other things, she could read for some time, when she again looked upon the page. The application of leeches relieved these symptoms for a day or two; but the relief was temporary, and she gradually lost the power of directing her eyes. From the beginning of this affection of the eyes, the pain ceased in the head. This " actual blindness came on periodically. It began about ten o'clock in the morning, and ceased about four; and, during the blindness, there was constantly presented a most quick motion of the eye-lids and eye-balls; and during the whole of these attacks, she lost all control over the muscles of the eye-lids and eye-balls. She could partly see, or at least distinguish light from darkness." Her vision was occasionally restored: at one time her medical man having made his visit, he was called back as he was stepping into his carriage, she having at that moment entirely recovered her sight. Her blindness has of late been permanent. Her physician looks upon these symptoms as connected with nervous irritability, and different from genuine amaurosis arising from disease of the optic nerve or retina. I should have stated that the solution of belladonna was applied to the eye-lids, by which her medical attendants satisfied themselves that there was no cataract. They next ventured upon the galvanic battery, and were encouraged to proceed in consequence of her being able to see almost on the first shock, which was given across the eyes. She found her way out of the room without assistance, and could distinguish the colour of the ladies' dresses who accompanied her in the carriage. After this, although a spark of light was excited at each shock of the battery, her sight did not improve; and she even lost that degree of vision which she had enjoyed in the morning and the evening.

This young lady has a pleasant, intelligent manner: but I observed to her, that she conversed with her ears! on which she said, " Oh dear, am I already so bad as that?" understanding perfectly what I meant,—that the direction of her countenance to those who addressed her was like that of a blind person. This expresses a fact, at the same time that it may show the acuteness of her understanding. Her eye-lids are dropped over the eye, but not with the character of a paralysis: they are in continual motion while she speaks, being raised and depressed for about the twelfth of an inch; and never so far raised as to expose the pupils; the eye-brows are raised by an ineffectual attempt to open the eye-lids. She can close the eyes and wink, powerfully compressing them. The secretion of tears flows plentifully. There is not the slightest degree of inflammation in the eyes. The concealment of the pupils is not altogether owing to the dropping of the eye-lids, but to the eye-balls being at the same time rolled upwards: she has an equal inability of raising the eye-lids and of depressing the eye-balls. If there be a difficulty of understanding this description, I would say that there is continually in this young lady that condition of the eye and eye-lids which the surgeon sees when he is about to examine the eye, or perform an operation on it: the cornea is turned up, whilst the eye-lid is forcibly drawn down—such is exactly the condition of this young lady's eyes.

The first thing I did was to stretch the eye-lids over the eye-ball, and keeping her face directed to the window, I inquired, "Do you see red light?" "No," said she, "but I see bright yellow light." I had forgot that when we look through the eye-lids the light is red, but if we stretch the eye-lids, so as to undo the furrows, we see a brighter yellow light. This fact was sufficient to show me that the defect of vision was not in the retina, but arose from a deranged action and want of consent in the muscles of the eye. I next inclined her face downwards, and forcibly raising the upper eye-lid, I disclosed a small part of the pupil, the eye-ball being powerfully rolled upwards: before I did this I said, "Let me try if you cannot see your surgeon;" and as soon as the pupil was disclosed, she said, laughing, "I see he has on spectacles." I next asked her to turn her eyes in different directions; she could turn them to the right and to the left, but she met with an uncontrollable opposition in rolling them downwards. To these facts let me only add this consideration: we might imagine that when the pupil is disclosed, however little, she ought to see distinctly; but this cannot be, for the light that then enters, enters obliquely, not in the line of the axis, and consequently the impression is not made on the more sensitive central part of the retina. If we are looking to the side of a room which is hung round about with pictures, we faintly distinguish the frames of the pictures lateral to our position, the light from these objects falling upon a part of the retina which is less sensible. It is not, therefore, any morbid insensibility of the retina which renders this young lady blind, but the fact that she cannot even for a moment direct her eye to the object, and consequently cannot receive the impression in the central portion of the retina, which is alone capable of distinct vision.

I expressed my opinion that this was an instance of that irregular muscular action which depends on some remote irritation, and is not referable to organic disease, either of the brain or nerves, and that I saw no reason why we should not hope for sudden restoration of sight.

Dec. 24th.—On conversing with the family again, I find that the above statement is correct. She, however, adds, " I wonder, considering the many questions you put to me yesterday, that I forgot a circumstance which is, perhaps, important; that I have pain extending round the head as if it were bound by a hoop. This is not continual, but is excited by the motion of a carriage or by noise. I have also," said she, " a whizzing noise in my ears, especially when I awake in the morning."

My first idea was to excite the viscera of the abdomen by emetics, and to follow these up by opiates.

January 3d.—During the operation of the first emetic her eyes opened, and she saw for a short time. On the second operation her eyes remained open for ten minutes. The opiates being then administered, on the first morning when she awoke she saw perfectly, but after a short interval she was again blind. This morning she met me with a still better account,—that she saw during all the time of breakfast, and had played a new song from the book. But what was most agreeable took place during my visit, for whilst I was writing my prescription, she called with interest to me to look at her! and, to my surprise, her eyes were open and steadily fixed upon me, her countenance was wholly changed, and I need not say improved; I thought that her sister had slipped into her seat. Her sight continued perfect whilst I remained in the house.

January 27th.—This happened twice afterwards, her eyes remaining open for the space of an hour. This was not altogether chance, but depended upon the high excitement of her mind whilst I conversed with her, she having the greatest confidence in my power to relieve her. I increased the dose of opium by giving her a pill at night and a draught of 35 drops of laudanum in the morning. It had the effect of opening her eyes for a longer period, that is, for an hour and a half or two hours; but it became oppressive to her, and I accordingly left it off. Fearing, during our bad weather, that the opiates and the confinement might affect her health, I gave her bark, and substituted the local application of opium for the opiate draughts, and with the most remarkable effect. A blister was applied to the temple, and a lotion of opium ordered to wash it with. The effect was almost immediate, but still it was temporary; however, with this advantage, that she could see when she chose, for by going up and bathing her temples with the simple opium lotion, she could come down stairs seeing perfectly for twenty minutes or half an hour.

February 2d.—To-day I had a pleasant scene with this young lady, for she met me, saying, with her usual cheerful manner, "I have got a way of restoring my sight as well as you, for there is a part of my temple, which, when I press with the point of my finger, my eye-lids are instantly opened." She put this in practice. Feeling for the little pit before her ear, and above the jugum, and pressing pretty firmly there, the eye-lids went up with a rapidity and effect as if she had touched the spring of a Venetian blind, and they remained open as long as she kept her finger there. She proceeded to inform me that she had found this accidentally, and that when she pressed both temples the relief was more complete, but that pressing on one side was sufficient to open both eyes, of which she made demonstration to me. I conceived at first that she had pressed upon some branch of the fifth nerve, for I could conceive nothing more likely to produce an influence upon the nervous system of the head; but when I pressed upon the divisions of the fifth pair on the forehead, and on the jaw bones, it had no effect. It next occurred to me that it was by pressing on the artery; to ascertain which, I stopped the pulsation of the carotid by pressing in the neck. Whilst feeling for this, she said, "I know that there is a part of the neck which has the same effect, but I cannot find it again." When I put the point of my thumb under the angle of the jaw, and pressed the carotid against the vertebræ, the effect was perfect, thereby proving that it was caused by some influence of the circulation over the nervous system of the head.

Some days afterwards, at my visit, she told me, that, on pressing at the pit of the stomach, the same effect was produced as on pressing the temple. This I found to be the case; for, on pressing down the cartilages over the left hypochondriac region, so as to press the cardiac portion of the stomach, the eye opened, and it remained open whilst I pressed. Being now more and more convinced that this affection of the eye depended on some very slight irritation, and she being in high spirits, I satisfied myself with putting her on the plan of tonics, such as steel, and a mild purgative, and permitted her to go into company. She enjoyed one night at the play, but returned from it with a severe headache, fell into bad health and bad spirits; no pinching any where could raise the eye-lids, and we were all full of disappointment. Dr. Babington was called into consultation: he prescribed pills of the cuprum ammoniatum. After eight days, her friends being alarmed with the increasing weakness and want of appetite, I once more changed the treatment to a draught of quinine and a pill of calomel, with the compound aloetic pill. She is at this moment obviously benefited by this: she has recovered her spirits, and, by opening the eye-lids of one eye, the other eye is disclosed also; and in a moderate degree she can enjoy her reading and drawing.

I remember no other instance like this, except one in the Medical Museum, in which the patient, a female, saw perfectly well in the morning till ten o'clock. When it "turned of ten" it seemed to her as if her eyes were covered with a cloud: and this darkening of her sight was preceded by convulsive motions in the integuments of her forehead. She was relieved by opium, but relapsed in consequence of some misfortune attended with low spirits.

We see how apt the practitioner would be to suppose this some singular affection of the optic nerve: a species of amaurosis contrasted with nyctylopia, since it seems inexplicable at first that the patient should see in the morning, become blind at ten o'clock, and remain so till four. There is a reflection, however, calculated to give comfort—as the symptoms vary, so must the cause also vary: and this proves that it is not organic; for if the cause were organic derangement, the symptoms would be permanent.

No. XIX.

Blindness from dropping of the Eye-lid: and imperfect motion in the Eye-ball.

A boy, about 11 years of age, was brought to me a twelvemonth ago. He was of a scrofulous habit, had a pale and sickly look, and had disease in his knee-joint. When the complaint which I have to describe commenced, it was in this manner. He came from school, and said to his mother, "The boys tell me I squint, is that true?" adding, "I saw two masters in the school, and two of every thing."

The boy is intelligent, docile, and (his mother says) acute. His countenance is very peculiar, from his eye-lids having fallen, and his eye-brows being elevated and arched. He cannot see without throwing back his head, and looking under his eye-lids, in the manner of a person who is trying to see from under a green shade. The reason of this is, that if he keeps his head in the usual position, he can only see the ground at his feet, but by throwing back his head, without changing the relative position either of his eyes or eye-lids, he is then enabled to see any thing on the same level with himself. He has a little more power over the left eye-lid than the right, but it is clear that he has not complete power over either of them. He raises the left eye-lid with his finger, and then says he sees his mother distinctly. Although he cannot raise the eye-lids, he can shut them firmly; winking, if the eye be irritated. In the attempt to open the eyes, he wrinkles the forehead, and arches the eye-brows, but only draws the skin of the eye-lids smooth, without raising the margins of them.

His mother says, that when he saw double, she observed his eyes were both turned to the right side; objects, however, do not now appear double. In the beginning, as now, there was a twitching of the face, and a drawing of the mouth a very little to the left side.

On attending more particularly to the motions of the eye-balls, the left eye is observed to move in a lively manner, but perhaps not to the full extent, and the right is more fixed; but when I close the left, and lift the eye-lids of the right, and place my face opposite to the pupil of the right eye, he sees me perfectly. Although he sees the light when I open either the right or the left eye, yet the iris of the left only is moveable. The pupil of the right is dilated.

This boy's health declined in the course of a few months. He first complained of pain in his right arm, and across his nails. He became subject to headaches, and flushing of the face; he had a wasting of the muscles of the thumb, and soon after an obvious withering of the whole arm. Before his death he became quite paralytic, and finally the paralysis extended over his body generally. Yet it was remarkable that when he slept, the left arm was always elevated above his head, and although his mother put it down twenty times under the clothes, in a very short time she found it again stretched above his head. He remained sensible until two days before his death. He said he was quite willing to die; and that as his surgeon had paid him greater attention than any person during his whole life, he hoped his mother would let him examine his body if he desired it.

The dissection of the brain exhibited all the common appearances of acute hydrocephalus: in the ventricles there were about ten ounces of fluid; the substance of the brain was exceedingly soft, so that it tore, and became flocculent in the water of the ventricles. On the base of the brain coagulable lymph was exuded, and it bound the roots of all the nerves, from the olfactory down to the ninth. The fifth was the most entire; the third of the right side was hardly discoverable amongst the coagulable lymph, from its having degenerated and acquired transparency. There were several scrofulous tubercles in different parts of the cerebellum and nodus cerebri.

Although there be a certain resemblance in the symptoms of these two cases, yet a careful observer will distinguish a nervous affection, proceeding from organic injury, in the one case, from that which is, in the other, purely spasmodic. In the boy, there was no part of the functions of the eye and eye-lids perfect but that which belonged to the portio dura of the seventh pair of nerves, that nerve which takes its course circuitously to the eye-lids by the ear and the side of the face; on the contrary, the functions of those nerves which came through the bottom of the orbit were more or less injured. I would be inclined to attribute the first train of symptoms to the condition of the base of the brain; no doubt, the state of the boy ultimately was referable to the hydrocephalic condition of the brain.

And now let me mark the difference of the symptoms in the lady's case. The disorder did not come on gradually, nor was it permanent at first; it came on like a sudden spasm, and as suddenly disappeared. We have next to observe that it is a morbid condition, mimicking a natural state of the eye; for the action of the eye is here the same as when a candle is held to a sleepy eye; it is the condition of the muscles of the eye, when the organ is excessively irritated. It may, therefore, be described as a natural action become permanent; such a condition, then, as is consistent with the idea of irritation upon the nervous system: it does not imply any actual defect, as in the other instance, where the eye-lid, instead of being tremblingly alive, hung motionless, and the eye-ball, instead of being turned up with a strength that implies spasm, was simply limited in its play, or altogether motionless.

No. XX.

Inability to close the Eye-lids.

In the preceding part of the paper I have mentioned the condition of the eye, in which it appears ever watchful; the eye-lids do not close upon it even in sleep, and it has been called *oculus leporinus,* from the vulgar notion that the hare sleeps with its eyes open. I have a young lady now under my care, in whom this condition of the eye was presented, in the early stage of the complaint, and it still in some degree remains. The detail of the case may be interesting to your readers. A very few years ago it would have appeared to me of the utmost consequence for understanding the functions of the portio dura and the fifth pair of nerves; even now its interest is only diminished to me from its frequent occurrence.

This lady, 22 years of age, was attacked six years ago with scarlet fever and sore throat. Inflammation appears to have been communicated through the Eustachian tubes to the interior of the temporal bones. On the left side, the inflammation went on to suppuration: the mastoid process became carious, and portions of bone were discharged through an ulcer behind the ear. A small bone, the form of which she cannot describe, was discharged also from the tube of the ear. During the progress of this inflammation, she never experienced any diminution of sensibility in the face; but a very unpleasant consequence attended this disease of the temporal bone, she became paralytic on all the left side of the face. During the violence of the attack she could not close the left eye. At this period, too, she felt pain in the collar-bone of the same side, and such a degree of difficulty of moving the shoulder-joint, that she describes it by saying it was like a rusty hinge. At present she is dull of hearing in both ears, more particularly in the left: her face is a little twisted to the right side; which becomes quite a distortion when she speaks, and especially when she smiles. The eye-lids of the left eye have recovered in a considerable degree, but still she cannot bring the margins of the eye-lids close together, and in attempting to shut them, the white part of the eye-ball is seen, as the cornea is turned up.

In this case all my efforts are directed to relieve the scrofulous action which has been set up in the tympanum. On the second visit I found that the use of stimulating fomentations to the ear, liniments behind the ear, and warm gargles, had the effect of removing the remaining paralysis of the eye-lids.

This case is important, 1st, as showing the office of the portio dura of the seventh pair of nerves; from its being affected in its course through the temporal bone, and depriving the corresponding side of the face of motion, without in any degree depriving it of sensation: 2dly, we see how the inflammation has been propagated from the throat into both ears; and we cannot but reflect on the unhappy consequences which would have resulted had the inflammation in the right ear gone on to suppuration; for then the muscular power of the lips, cheeks, and eye-lids would have been lost on both sides, and the consequences need not be described*: 3dly, we are directed by the affection of the nerves to the condition of the temporal bone; and it cannot escape observation that the temporal bone is a bone of the cranium, in contact with the brain; and there is danger of that affection of the brain which by the old pathologists was called vomica cerebri. The circumstances of pain and debility in the arm during the violence of the inflammation sufficiently point out the danger of her condition at that time, and that it should still be our principal object to prevent any accession of inflammation in the temporal bone, and to preserve the discharge free.

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* See the case below of the patient who was in the Hotel Dieu, under M. Depuytren.

No. XXI.

Case illustrative of the action of the Levator Palpebræ Superioris.

I am tempted to describe the condition of a patient now under my care, because it exhibits a succession of those phenomena which we seek to explain. He presented himself to me in the hospital with a distinct squint, the left eye being distorted from the object. On the eye-lid of the right eye there was a deep venereal ulcer: the man was in danger of losing this eye, and required prompt assistance, but before he could be brought under the influence of mercury, the inflamed sore became deeper and the cornea opaque. The superior rectus muscle being, as I suppose, injured by the increasing depth of the sore, the pupil became permanently depressed. The sight of the right eye being now lost, the left eye came into use; it was directed with precision to objects, he had no difficulty in using it, and it daily became stronger.

After a few weeks, medicine having had its influence, the sore on the upper eye-lid of the right eye healed, the inflammation and opacity of the eye gradually diminished, the light became again visible to him; first it was yellow, and then a deep purple. And now the muscles resumed their influence, and the eye was restored to parallel motion with the other, so as considerably to embarrass the vision. But the inflammation of the upper eye-lid had been so great, as to diminish its mobility; and what appeared most extraordinary, the lower eye-lid assumed the office of the upper one, and a very unusual degree of motion was remarked in it. It was depressed when he attempted to open the eye, and elevated and drawn towards the nose when he closed the eye. The upper eye-lid was not only stiff, but diminished in breadth; so that notwithstanding the remarkable elevation of the lower eye-lid, their margins could not be brought together, and we could perceive the motion of the eye-ball; in his attempt to close the eye we constantly saw the pupil elevated, and the white part of the eye exposed.

I shall now attempt the explanation of these phenomena.

The impression upon the left eye had been weak from infancy, and the retina being unexercised, the recti, or voluntary muscles, wanted their excitement, and were deficient in activity; the involuntary muscles therefore prevailed, and the pupil was turned upwards and inwards, and consequently removed from the axis of the other eye. But when that other eye became obscured, the left eye being the only inlet to sensation, the attention became directed to the impression on the retina, the voluntary muscles were excited to activity, and they brought the eye to bear upon objects. This eye improved daily, because the natural exercise of a part is its stimulus to perfection, both in function and in growth. When the right eye became transparent, and the light was admitted, the voluntary muscles of that eye partook of their natural stimulus, and commenced that effort in search of the object, which in the course of a few days brought the eye to its proper axis, and both eyes to parallelism.

The next thing that attracts our attention in this short narrative is the revolving of the eye-ball. It has been explained in a former part of the work, that when the eye-lids are shut, the recti, or voluntary muscles, resign their office, the inferior oblique muscle gains power, and the eye-ball traverses so as to raise the pupil. It will not have escaped observation, that the pupil of this eye was depressed, and could not be elevated by a voluntary act for the purpose of vision, owing, as we have supposed, to the injury of the rectus attollens, at the same time that it was thus raised involuntarily, in the attempt to shut the eye; a proof that this insensible motion is performed by the lower oblique muscle, and not by the superior rectus muscle.

The circumstance of the lower eye-lid assuming the functions of the upper one, and moving like the lower eye-lid of a bird, reminds me of an omission in the account of authors. They have sought for a depressor of the inferior eye-lid, which has no existence, and is quite unnecessary; for the motion of the *M. attollens palpebræ superioris* opens wide the eye-lids, and depresses the lower eye-lid, at the same time that it elevates the upper eye-lid. If we put the finger on the lower eye-lid when the eye is shut, and then open the eye, we shall feel that during this action the eye-ball is pushed outwards; and we may observe, that the lower eye-lid is so adapted as to slip off the convex surface of the ball, and is consequently depressed. The reason of this is, that the muscle which raises the upper eye-lid passes over a considerable part of the upper and back part of the eye-ball, and the origin and insertion of the muscle being under the highest convexity of the ball, that body must be pressed forwards in proportion to the resistance of the upper eye-lid to rise. In the preceding case the upper eye-lid being stiff and unyielding, both the origin and the insertion of the *elevator palpebræ* became fixed points; consequently, the action of the muscle fell entirely on the eye-ball itself, whereby it was forced downwards and forwards in an unusual manner, and so depressed the lower eye-lid to an unusual degree. Thus the muscle became a *depressor* of the inferior eye-lid, instead of an *elevator* of the upper eye-lid! The motion of elevation in the lower eye-lid was of course performed by an increased action of the lower portion of the *orbicularis palpebrarum.*

No. XXII.

Extract from Mr. Shaw's Paper on Partial Paralysis, in the Medico-Chirurgical Transactions.

"A good example of complete paralysis of the levator palpebræ, and of loss of power in the pupil, without any affection of the retina, occurred last winter; and I was fortunate enough to have an opportunity of examining the body after death. A young woman had a fungous tumour under the jaw; the cheek of the same side was paralytic: the upper eye-lid of the same side had fallen; but when the eye-lid was raised, the patient could see distinctly, although the pupil was fully dilated and immoveable. Upon dissection, it was found that the tumour had extended into the lateral part of the orbit; the fourth nerve ran over the tumour, the third was in the substance of it, but the ophthalmic division of the fifth pair was the nerve most destroyed; the sixth was partially affected. The tumour did not reach as far as the optic nerve. Since all the nerves of the orbit, except the optic, were included in the disease, we cannot draw any further conclusion from this case, than that the motions of the iris do not altogether depend upon the state of the optic nerve. The voluntary power which some individuals possess over the motions of the iris will perhaps be considered as in some degree supporting the view which I have taken. The members of the Society are, no doubt, aware, that one of their most distinguished associates has this voluntary power over the motion of his iris. Upon an occasion in which the gentleman I allude to, was so kind as to show me to what an extent he could exercise this power, I thought I could perceive that the exertion which attended the attempt had some effect upon the motions of the upper eye-lid."

The following shows the dependance of the action of the muscles of the eye on the sensibility of the retina.

No. XXIII.

Case of Strabismus with Affection of the Eye-lid.

Cromer, March 11, 1829.

"Sir,—I feel much obliged by the favour of the letters I received from you; beneath you will see the remarks I have been able to make on the case, and I shall always be happy to contribute such others as it may be in my power to supply.

"I am, Sir,
"Yours most respectfully,
"C. S. Earle.

"In Wortley, the falling of the eye-lid is not the whole cause of one eye only being used at the same time. The foci of the eyes are not alike, the focus of the right (viz. the sound eye) being the common distance, while that of the left is several inches more. When the right eye is directed to any object, the left eye-lid falls, but it can be elevated at will, though not completely so; when it is thus elevated the eye-ball is turned upwards and outwards, and is then not under the influence of the voluntary muscles; but if the right eye-lid is closed, the left eye-lid can not only be elevated, but the eye-ball will resume its proper position; it cannot, however, be turned in the slightest degree further towards the nose; it can be directed downwards, but then the eye-lid follows it, and half closes it; when an effort is made to move it upwards, it inclines slightly outwards at the same time; it perfectly retains the power of being directed outwards.

" The right eye can be turned in any direction by the voluntary muscles.

" When he looks at an object with the left eye he drops the right eyelid, but after a short time he can elevate it again, without altering the position of the left eye; the right eye, however, will be found precisely in the same state as the left is in, when the right eye is used (viz. turned upwards and outwards, and not under the influence of the voluntary muscles until the left eye is either closed or directed from the object).

" If the finger is applied to the left eye-lid while it is closed, and an effort is made to shut the right eye, the eye-ball can be distinctly felt rolling upwards and outwards.

" He is not troubled with seeing red or yellow light through the closed eye-lid.

" The power of sensation, and also of expression (except so far as I have noticed), is perfect on each side of the face."

No. XXIV.

Case of Partial Paralysis.

" Mary Brown, æt. 15, a pale and emaciated girl, was in the physicians' ward for an obstinate constipation of the bowels, and for some symptoms of paralysis.

" We learn, that when four years old she fell and struck the back of her head; she was stunned by the blow, and remained insensible for a short time. She was for two days sleepy and lethargic, when it was observed that the left side of the body was completely paralysed; this paralysis continued for fifteen months, without any amendment taking place. After this period she improved slowly, and at the end of another twelvemonth she was so far recovered as to be able to walk; the disease then remained stationary, and no alteration appears to have taken place up to the present time.

" She is in a very feeble condition: the paralysis seems now to be confined to the left side of the face, with the exception, however, of the left arm, which is much weaker than the right. There is not only a want of power in the muscles of the left arm, but the sensibility of the extremity is evidently impaired, for she is unable to perform those actions which require the combination of the delicate sense of touch, and the finely-regulated action of the muscles. She cannot pick up a pin.

"The sensibility of the left side of the face is but little affected. The parts supplied by the portio dura on this side have lost all their motion; the mouth and right ala of the nose are dragged towards the right side. She is unable to move the left side of her face, even in the slightest degree. When she smiles, this side is void of all expression, and is in strong contrast with the opposite side. She says that the food is apt to lodge on this side of the mouth, betwixt the cheek and the gums. The inability to close this eye-lid affords us a good opportunity for observing the motion of the eye-ball in the act of winking. Every time that she winks, the uncovered eye-ball of the left side is turned up, and as quickly descends again. This motion of the eye-ball is performed with extreme velocity, but at the same time is so obvious and demonstrable, that the most careless observer could not overlook it. In order to see the same motion of the eye-ball performed more slowly, she was desired to attempt to close her eye-lids; when it was observed that the eye-ball was turned up in the same manner, and remained so until she again unclosed the eye-lid of the right side. The senses of taste and hearing on this side are impaired; the sight is dim, but she sees the whole of an object. The tendency to constipation of the bowels was coeval with the paralysis, and, no doubt, depended upon it." From the House-Surgeon's Case-Book.

This is one of the cases where the brain has been so influenced as to affect the whole nerves, both of sensation and volition, of one side. As to the fact of the rolling of the eye, it is conclusive.

The following note was drawn out by one of my pupils:—

No. XXV.

Case of Partial Paralysis of the Face.

"During the last course of lectures in Windmill Street, while Mr. Bell was giving his lectures on the nervous system, a gentleman, who had been a pupil of another school of anatomy, came to consult him on his own case. His face was distorted, the muscles being completely paralysed on one side; he retained the sensibility equally on both sides. He presented the exact case, which we had heard described at lecture as an affection of the *portio dura* of the seventh pair of nerves.

"We observed the eye-ball of the side affected. When he winked, the eye-ball revolved upwards and inwards, and there was no doubt or difficulty in observing this movement, as the eye-lids remained wide open at the time when the eye-lids of the other side contracted.

"He ascribed the origin of this affection to having imprudently sat without his coat reading at an open window, after being fatigued and heated with a long ride. This paralysis of the face, and a stiffness of the neck, attacked him nearly at the same time.

"We (the students present) showed him the dissection of the nerves of the face, which had been prepared for lecture. He examined it with great interest, and the explanation of his case was apparently new to him."

I have lost the other notes on this case.

If the reader will turn to authors upon the diseases of the eye, under the head of *Lagophthalmia*, he will see how much practitioners are mistaken in applying the remedies to the eye-lids in this disease, when the cause may be in the temporal bone, or the glands near the angle of the jaw, or some remote nervous irritation. Oculists, as Richter, for example, when the eye-lids do not close, recommend rubbing the eye-lids once or twice a day with a drop or two of fennel oil, frictions upon the eye-lids with the tinctura cantharidis, blisters near or immediately upon the eye-lids, the application of cold water to the eye by means of compresses wet very often in the course of the day, &c.

No. XXVI.

Case of Paralysis of the Face.

"January 2, 1827, Daniel Stalder accompanied his wife, who had a paralytic stroke, to the Middlesex Hospital. It was observed that the left side of his face was much distorted, and there was great wasting of the muscles. He was examined by Mr. Bell, before the pupils of the hospital, and it proved to be a case of paralysis of the portio dura. The two sides of his forehead presented a very striking contrast: the right side was furrowed with deep wrinkles, which were more strongly marked when he frowned; and a large fold of the skin was prolonged down upon the same side of his nose, which marked the descending slip of the occipito frontalis muscle. The left side of his forehead was perfectly smooth, the skin appearing to be stretched tightly over the bone, and there was no motion of the integuments in the act of knitting or elevating his eye-brows. His left eye-lids were quite motionless. When he was desired to wink, this eye remained open, and the cornea was elevated so as to be quite hid under the upper eye-lid. This eye appeared a little duller than the other, yet he says he never had any disease in it. He cannot see so clearly with it as with the other eye. The left nostril is collapsed, and has not that fulness which the right possesses. He seems to retain some power of acting with his cheeks, as in whistling there is a slight quivering observed. Although his lips are dragged to the right side, they do not appear to be totally deprived of muscular power: he can grasp the point of the little finger pretty firmly when it is introduced into the left angle of his mouth. The muscles of the neck are perfect: the fibres of the platysma myoides start out when he puts it into action. The skin has its natural degree of sensation. He states that he has had this affection since he was a child. He has had no deafness; nor any disease which he can remember to have preceded this distortion of his countenance."

I have introduced this case, because the patient is at this time about the Middlesex Hospital, and can be seen as affording an instance of the effect of early paralysis in the seventh nerve.

On one point the following case is unsatisfactory, and, therefore, I am bound to give it:—

No. XXVII.

Partial Paralysis.

"I take the liberty to transmit to you this case, as it is curious, and bears strongly on the physiological doctrines taught by Mr. Charles Bell. If you are acquainted with him, or could obtain his opinion on it, I should feel much gratified, and greatly obliged to you.

"I am, Sir,
"Your obedient Servant,
"J. Webster.

"Ramsgate, 22d August.

"A healthy male child, four months old, of a plethoric habit, was very restless during the night of the 11th of August; a dose of calomel and scammony had been given him the day before, and the mother supposed the restlessness was owing to this circumstance. She observed, however, that when he cried, his face was drawn forcibly to the left side. 12th. The aperient was repeated. 13th. On a careful examination there is nothing remarkable behind the ear or about the angle of the jaw, and the child allows the parts to be handled without shrinking. There is an evident puffiness above and below the zygoma. With the exception of the eye, the features on this side of the face of this lively laughing little fellow are quite without expression. When he laughs, the muscles of expression on the left side are thrown into considerable action, and when he cries, (from the loss of all antagonising power,) into the most disagreeable distortion, the right eye remaining wide open; the orbicularis palpebrarum, the corrugator supercilii, as well as the rest of the muscles on this side, remaining quite relaxed. The nose is drawn to the opposite side."

The communication describes the remedies and their effects, and then proceeds:—

"When he is made to wink, the left eye-lid moves with rapidity, whilst the right is quite stationary. The *occipito frontalis* partakes also of paralysis; for when the child looks earnestly at any object, the eye-brow and skin of the forehead on the left side are drawn upwards, but on the right there is no corresponding motion. During sleep, the affected eye is only partly closed. The sense of feeling is alike on both sides of the face."

In writing to Mr. Webster, I requested to know the condition of the eye-ball; the answer was not satisfactory.

"October 6, 1826.

"The right side continues relaxed and flabby, so as to give to the cheek the appearance of being larger than the other. The upper lip, on the affected side, overhangs the lower. If the child's attention is fixed, and the hands are suddenly clapped together before the face, the left eye-lids move rapidly, and the right upper eye-lid in part falls and recedes with a trembling motion, but the eye-ball is not moved. When the child sleeps, the aperture formed by the want of approximation of the lower eye-lid to the upper, crosses about the middle of the cornea; so that the direction of the eye-ball is that of a person looking downwards. On raising the eye-lid with the finger, so as not to disturb the child, and holding a strong light suddenly before him, the eye-ball is pulled downwards and outwards."

The letter concludes with an apology for not answering my letter sooner, "owing to the almost constant habit of the child nestling his face in the pillow, as it were to avoid the annoyance from light which the open eye is exposed to."

This is the only instance in which observation is at variance with my statement, that the eye-ball revolves upwards when the eye is threatened.

It is not necessary to carry the proofs further. In the following instance, extracted from a long and circumstantial case, the same effects are seen which result from the paralysis of the portio dura of the seventh nerve.

No. XXVIII.

" —— Masters, æt. 27.—His friends first remarked the distortion of the face. One eye was more disclosed than the other. The eye-lid of the left side did not move when the other was winking. This eye was notwithstanding clear, because the inferior part of it was covered by the lower eye-lid, whilst the upper part was moistened, during the act of winking, by revolving upwards under the upper eye-lid. When he was asked to blow his nose, the eye turned suddenly upwards under the eye-lid."

No. XXIX.

Paralysis of the Face from injury of the temporal bone.

I received from Mr. Perry, of Great James Street, a note, giving me the account of a child who fell from a swing, and had paralysis of the face. He was stunned, and bled from the right ear, and was deaf in that ear. Three weeks after, the child became paralytic on the right side of the face, with great distortion of the features. After a judicious antiphlogistic treatment, without effect, the paralysis disappeared under the influence of mercury.

This is not a solitary instance of paralysis of the face from injury of the temporal bone. It will be readily admitted, that whilst it was believed that the five branches of the fifth pair of nerves, distributed to the face, were muscular nerves, or nerves of voluntary motion, such a distortion as this could not have been attributed to its real cause, the injury of the portio dura in its course through the bone, but, on the contrary, to the injury of the brain itself. This case, therefore, affords another proof of the practical benefit to be derived from knowing the distinction in the functions of the fifth and the seventh nerves.

No. XXX.

Disease of the Face.

Eliza Smith.—The following is one of the cases which is demonstrative of the distinct functions of the seventh and fifth nerves.

"The disease from which this woman suffers has been supposed to be that sometimes called *Noli me tangere*, and in its more aggravated form, *Lupus*. The nose was destroyed by a slow process of ulceration, which opened the cavities of the face, so that we could look into the œthmoid and maxillary cells. At this stage an ointment was used which had the happiest effect wherever it could be applied, and she appeared nearly well. But a small speck of ulceration remained upon the os planum, deep in the cavity: it could not be arrested. The disease in that way got into the orbit.

"The eye-ball became now protruded from the socket, with tension of the eye-ball and tumefaction of the conjunctiva, attended with excruciating pain. At length the eye-ball became so much pushed out, that the eye-lids could not meet; the cornea was continually exposed, and became opaque." (And now the symptoms began to bear on our present subject.) "The sensibility of the surface of the eye, though in a state of ulceration, was lost. She could press her finger upon the eye. The forehead of the same side, the lip, the cheek, and side of the nose, were deprived of sensibility; at this time she could move the eye-lids, although she could not close them from the bulk of the eye, and she had the motion of the cheek and lips.

"When the eye and temple were perfectly insensible, and when, as she herself said, she could pick off the scales from the surface of the eye without feeling at all, she was tortured with most excruciating pain seated in these very parts; that is to say, referred to these parts."

But on the 28th December there is a note of this patient's case, which describes the swelling to have extended to the temple, the eye to have fallen, and where there was insensibility before, she could not bear the touch of a soft sponge.

"She for some time previous to this, complained of a drumming and a weary pain in her right ear; and now she cannot knit her brows, or move the eye-lid, and when she speaks or blows there is a stillness in all that side of the face."

This case requires little comment. The swelling of the parts within the orbit, compressing the fifth nerve, caused insensibility of the part of the face to which these branches were distributed without affecting the motion.

When the tension and swelling subsided, there was returning sensibility; but more than this, the inflammation affecting the nerves in their passage through the orbit gave the sensation of excruciating pain, perceived as if in the face. An inflammation of a nerve does not give perception of pain in the proper seat of the disease, but in the part to which the extremity of the nerve is distributed.

Whilst the sensibility of the face was recovering (by the diminution of pressure on the nerves in the orbit), the motion of the features was arrested. But previous to this the ear became affected, by which it is implied that the seventh nerve had become compressed, or engaged in the progress of the swelling.

I shall add here some familiar instances and cases to show the importance of the knowledge of the nerves of the face in the investigation of disease.

No. XXXI.

"J. Richardson, October, 1820. On first looking at this man, there does not appear to be any thing unusual in the state of his face; but the moment he speaks or smiles, the mouth is drawn to the left side. When he laughs, the distortion is increased; and when he sneezes, the difference between the two sides is quite extraordinary.

"On holding ammonia to his nose, it was observed that he could not inhale freely with the right nostril; and, on examining the state of the muscles, when the act of sneezing was excited by the ammonia snuffed up by the left nostril, it was found, that not only those of the right side of the nose and mouth, but also of the eye-lids, were passive, while all the muscles of the left side were in full action. When he blew, or attempted to whistle, the air escaped by the right angle of the mouth, the right buccinator not at all corresponding in action with the muscle of the left side, nor with that of the muscles of the chest and neck, by which the air was expelled. The sensibility of the paralysed cheek was equal to that of the other side, and he could close his jaws with equal force on both sides."

The early history of the case, according to the account given by the patient's friends, was this :

" He was seized with a severe pain under the ear, and in a short time became so delirious, and his face so distorted, that the people in whose house he lodged, supposing him to be mad from brain fever, carried him to the parish work-house. There he lay until his friends discovered him, and brought him into the hospital. It was then found, that the frenzy which had led the people of the lodging-house to suppose that he was mad, was only a high state of delirium, in consequence of a severe attack of cynanche parotidea. Indeed the inflammation had run so high, that an abscess formed and burst under the ear. When the swelling subsided the degree of paralysis was very observable."

The delirium and the paralysis of the face naturally led the medical gentlemen who first saw this patient to suppose that the symptoms were caused by an affection of the brain. Luckily, the treatment generally followed in cases of phrenitis was best adapted for the particular affection which had caused both the delirium and the paralysis. The portio dura being engaged in the inflammation under the ear was the true cause of the paralysis.

For the next case I am indebted to a physician in Worcester :

No. XXXII.

"Worcester, July 25, 1824.

"Dear Sir,—My acquaintance with the nature of your late researches upon the functions of the nerves induces me to send you the following case:

"A young gentleman, aged 14, residing in the village of Kempsey, in this county, was observed by his family to have the expression of his countenance much altered. As long as the features were quiet, nothing unusual was observable in the countenance; but as soon as any passion was excited, the expression of the face was so different to what was natural to him, that his brothers and others of the family complained of his 'making faces at them.' He, in fact, smiled, laughed, or frowned only upon the left side of his face, the muscles of the right side remaining inactive; and, as they passively yielded to the contraction of the muscles of the left side, the countenance, of course, was much distorted whenever these were called into action. He lost the power of whistling, and, for the same reason, of blowing, and was unable to close his right eye. The sensibility of the right side was as perfect as that of the left. He was quite unconscious of any change in himself, and was not at all aware of the distortion of his countenance when he smiled, &c. This affection did not occur suddenly, but seemed gradually to increase, and became so evident in the course of a week, as to induce the father of the young man to send for his apothecary, Mr. Bick, of Kempsey. When Mr. B. saw him he found the symptoms as above stated; but upon examining the right side of the face more minutely, he discovered a fulness immediately beneath the right ear, produced by a hard, fixed, and indolent tumour, lying between the ramus of the lower jaw and the mastoid process of the temporal bone.

"He ordered him some aperient medicine, and directed the tumour to be rubbed with camphorated oil. In a fortnight the tumour disappeared, and with it, gradually, the paralysis of the muscles of that side of the face. It is a fortnight since Mr. Bick first saw him, and he has now recovered every power, excepting that of blowing or whistling. I saw him several times during the progress of his cure. It appears to me that the portio dura of the seventh pair was, in this case, injured by the pressure of an enlarged gland soon after its emergence from the stylo-mastoid foramen, and that upon the removal of the pressure its functions were restored.

"I remain, dear Sir,
"Your obedient servant,
"Jonas Malden, M.D."

The danger to which the eye is exposed by paralysis of the portio dura, or by any operation on the face, in which its functions are not attended to, is well illustrated by the following case:—

No. XXXIII.

"This poor man, about nineteen years ago, was attacked by a severe pain accompanied with discharge from the right ear. After a paroxysm severer than usual, he found, on getting up one morning, that the right side of his face was paralytic. His present condition, and the description which he gives of the progress of the symptoms, prove that the same results followed this paralysis, as in the instances already related. But what this poor fellow particularly laments is, that since the day he was first attacked, he has not been able to close his right eye; and well he may regret this, for the constant exposure of the eye to the light and dust has been the cause of many attacks of inflammation, and, consequently, of opacity of the cornea, so that the vision is now entirely lost. This, I fear, will often occur in similar cases, for I have observed that the eye has always become inflamed in those animals in which the portio dura has been cut. It is worthy of remark, that the inflammation has been more severe in the dog and in the ass than in the monkey. One great source of the increase of the inflammation is the purulent secretion from the conjunctiva; this the monkey wiped away with his hand; but it lodged between the eye-lids of the dog and of the ass, so as to form an additional source of irritation."

The ultimate effects of the loss of power over the muscles of the face, in consequence of an affection of the portio dura, are shown in the following extract:—

" A most remarkable appearance in the face of Garrity is the wasting of all those muscles of the face which are subservient to respiration and expression. His cheek is so thin that when he speaks it flaps about as if it were only skin, and the corrugator supercilii and occipito-frontalis, which are principally muscles of expression, are so wasted, that we might, at first sight, suppose they had been removed by operation, and that now the bones were only covered by skin. There can be little doubt that the wasting of these muscles has been in consequence of their long inactivity; since the masseter and temporalis muscles of the same side, which retain their office, are not at all diminished in size, being as large as those of the opposite side."

A curious example of a contrary effect produced on the growth of the muscles of respiration and expression, by an injury of the portio dura, was afforded in an experiment made upon a young dog. After the nerve was cut he was taught to snarl whenever a stick was held out to him; this being often repeated, the muscles of the side upon which the nerve was entire became very strong, while those on the paralysed side rather diminished than increased as the dog grew older. In a few months the one side of the face was much larger than the other. Every day we see similar results following palsy of the muscles of the limbs.

Many instances will now occur to my reader of cases where the paralysis of the face, consequent on a local affection of the portio dura, has been mistaken for an attack of apoplexy, and the patient treated accordingly. In one case the patient, after having undergone the discipline of bleeding, purging, and starving, and after having had his head shaved and blistered, was suddenly cured by the bursting of an abscess in his ear.

No. XXXIV.

" In another gentleman, the disease commenced with a violent pain below the ear, and in a short time one side of his face became paralysed. For this paralytic affection he consulted many eminent men. The first plan of treatment was bleeding, blistering, and starving, the disease being supposed to have its origin in the brain; but as he got rather worse than better under this treatment, he was put upon a course of mercury, which was carried to such an extent, that he lost several of his teeth. After he recovered from the bad effects of the mercury, he was recommended to attend only to the state of his digestive organs. But the blue pill had no effect upon the distortion. The last advice which this gentleman received was to wear an issue in his neck; with this, however, he has not complied, as he feared it would, like some of the other remedies, have the effect of rendering him more uncomfortable."

A great many cases, somewhat similar, have been presented to me by my pupils; I will add only three other instances, two of which are from papers by Mr. Shaw.

The first regards a patient who had suffered an attack of common apoplexy; it may be offered in example of that train of symptoms which is consequent on an affection of the original or symmetrical system of nerves, and as distinguishable from those which follow an affection of the superadded class. The second is of a man, in whom both the portio dura and the fifth had been injured by a blow; and the third is of a patient in whom both these nerves seem to have been affected by a disease within the skull.

No. XXXV.

"J. Cooper.—This man's general appearance is completely that of an old paralytic, but the distortion of his face is more remarkable than usual, in consequence of the right or paralysed side being marked with a red blotch.

"The arm and leg of the same side are nearly powerless, his intellects are much impaired, and his memory gone. The history of his case was given very clearly by his wife. According to her account, her husband was, for the first time, attacked with apoplexy about seven years ago; from this attack he gradually recovered, but at the end of twelve months he was a second time seized, and, since that period, he has had two distinct attacks every year; for the last two or three years he has been nearly in the same condition as at present.

"*State of the cheeks and mouth.*—When he is made to laugh, the right cheek rises in the same degree with the left; when he blows (he always bursts into a laugh when asked to whistle), the buccinator of the right cheek is in as much action as on the other side. When his nose is irritated by snuffing ammonia, the actions of the muscles, preparatory to sneezing, are equal on both sides of the face. The right cheek, and the right side of the mouth, fall lower than the left. When a piece of bread was put between the teeth and right cheek, the patient could not push it from its place, but was obliged to pick it out with his tongue. The saliva constantly flows from the right side of his mouth, and when drinking, part of the fluid escapes from the same side. The loss of the sensibility of the orbicularis oris was farther shown by the inability to hold a pencil, or a tobacco-pipe, in the right side of his mouth.

"The comparative degree of sensibility in the two cheeks was next examined; when he was pricked on the right cheek with a needle he seemed perfectly insensible, even though I drew blood; but on giving the least prick to the left side, he immediately started; the same difference in the degree of sensibility was observable in pulling a hair from each whisker. The sensibility of the right and left limb corresponded with that of the cheeks.

"On putting hartshorn to the right nostril he inhaled it as well as with the left, and immediately all the symptoms observable in a person about to sneeze were presented*. As the nose was turned up, and the alæ nasi of both sides were equally in action, this was a sufficient proof of the state of the paralysed side being here very different from the condition described in the foregoing cases. The power of the fifth over the nose was tried: by tickling the inside of the right nostril no effect was produced; but on tickling the left nostril the symptoms of sneezing were again evident.

"The motion of the eye was perfect.

"He could close the eye-lid of the paralysed side as well as the other; and when his nose was irritated by the hartshorn, or when he laughed, the orbicularis oculi and corrugator supercilii were in complete action, so that there was not here that heaviness in the expression of the upper part of the face, which is so remarkable in paralytic persons. Here, then, was proof that those actions of the eye-brows which we find to be deficient, when the portio dura is affected, are, in a case of common palsy, left entire; indeed, we may have daily opportunities, while walking in the streets, of observing that patients with palsy of one side of the body, have no difficulty in closing the eye-lids."

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* The apparent sensibility of the nostril over which the fifth had lost its influence may be explained, by supposing that the fumes of the ammonia passed by the posterior nares to the other nostril, and thus caused sneezing.

In the next case, both systems of nerves seem to have been affected.

No. XXXVI.

" Phipps, a bricklayer, on the 1st of September, 1821, fell from a scaffold thirty feet high. His right clavicle was broken, his right loin and hip were much bruised, and he received a severe contusion on the head, the marks of which were particularly observable in a puffiness behind the right ear, and in bleeding from the same ear and from the nose.

" He was in a state of stupor when brought into the hospital, but from this he recovered in the course of the day. For the two or three first days he appeared to suffer only from the effects of *concussion*, never having any of those symptoms which are generally attributed to *compression*. On the fourth day it was observed, that the angle of the mouth was drawn rather to one side, and there was also a degree of inequality in the contraction of the pupils.

" On the sixth day it was remarked, that while he was asleep, the right eye was more than half open, while the left was closed.

" The notes of the case are very full up to the 24th of September, and show that the patient had, during the interval, gone through the common series of symptoms which accompany that slight inflammation of the brain which is often the consequence of concussion.

" On the 1st of October, he was made an out-patient, his face being, at this time, very much distorted. The general appearance of his face was that of a man who has suffered paralysis from apoplexy; but it was further remarkable, that when he spoke or laughed, the distortion was much increased, the mouth being pulled more to the left side than I ever saw in any other patient.

" The following notes were taken at this time. There appears to be total paralysis of the muscles of the right side of the face. When he smiles or laughs they are passive, while those of the left are regularly in action. If he attempt to whistle, he cannot close his lips sufficiently; when he blows, the right cheek is dilated, but passive like a distended bladder; he can smoke, by putting the pipe into the left side of his mouth; he throws the smoke out of the right side, but in doing this, the action is evidently confined to the muscles of the left cheek.

" The cheek and mouth hang down, as in the common case of hemiplegia—he cannot by a voluntary act move his cheeks; when a piece of bread is put between the cheek and teeth of the right side, he cannot push it out with the buccinator, but picks it out with his tongue. He cannot hold his pipe or a pencil with the right side of his lips. These may be considered as sufficient proofs of the total paralysis of the muscles of the face.

" The difference of the sensibility in the two cheeks was very distinct. When a hair of the right whisker was pulled, he was not conscious of pain; but he started immediately on pulling one from the left. When his cheeks were pricked with a needle, his expression was—' I feel you push against the right side, but in the left you prick me.' When he brought his jaws forcibly together, he said he was not conscious of striking his teeth on the right side, although he felt them most distinctly on the left. On examining the state of the nose, we found that it was impossible to excite the muscles of the right nostril to any action.

" Both the orbicularis oculi and corrugator supercilii were so completely paralytic, that he could neither close his eye, nor knit his brow on the right side.

" On examining how far the branch of the fifth, which passes to the eye and eye-lids, was affected, we found that the symptoms did not exactly correspond with those observed in the parts regulated by the other divisions of the fifth pair, for when a hair was pulled from each temple, or from the eye-brows, the pain felt in the two sides was nearly the same. Neither the temporalis, nor masseter muscles of this side were paralysed. The motions of the eye-ball were so far perfect, that he could follow an object carried before him, but he could not direct both eyes truly, he saw double.

The contraction and dilatation of the pupil of the right eye were much the same as in the other eye.

" He can put out the tongue and move it in every direction with the greatest ease: the motions are all apparently correct and natural; he can throw a morsel from one side of the mouth to the other, and towards the throat, and he can pick it out from between his cheek and teeth.

" These observations led us to conclude, that not only the motor linguæ, or ninth nerve, but also the glosso pharyngæal were perfect."

This case differs from the common examples of partial paralysis of the face, not only in there being evident marks of paralysis while the muscles of the face are at rest, but in the sensibility of the skin of the same side being in a great measure destroyed. It differs also from the case of hemiplegia.

The first difference which we observe in it, from the case of common hemiplegia, is, that the paralysis is confined to the face. Secondly, that the paralysis is on the same side with that on which the head is injured. Thirdly, that the palsy is more evident, when the patient is made to sneeze or laugh. From these circumstances, we may conclude that there was here an injury of the skull affecting both the fifth and the seventh nerve.

No. XXXVII.

James Gulland, ætat. 26.—Was admitted into the Middlesex Hospital, April 15, 1823. His mouth and left cheek are twisted towards the right side: the whole surface of the left side of his face is insensible: he has lost the power of moving the eye of that side, and it has lately become inflamed; he complains of a deep pain in the temple of the same side.

His trade has been so profitable as to enable him to live in a most dissipated manner during the last five years. He has frequently strolled about the streets at night in a state of drunkenness, and has for three weeks never thrown off his clothes, and has been seldom in bed. He has been twice affected with syphilis; he was confined by his first attack for eighteen months, during which time he was under the influence of mercury. After regaining his health, he frequently experienced a pricking pain in his left eye and temple, so severe as to prevent his reading, especially by candle-light. About twelve months ago he was knocked down: he fell on the back of his head, and wounded the occipital artery; he thinks that he has never been quite well since that time. On the 13th of October, last year, one of his comrades noticed to him that his mouth was drawn to one side; this induced him for the first time to observe in a looking glass the condition of his face. He tried to spit, and observed that his saliva, instead of passing through the centre, was squirted out of the right corner of his mouth, which was contracted. His lips were in other respects perfectly natural, being possessed of sensibility and the power of motion. He could then likewise close the eye-lids of the left eye, but to do this he required to shut the other eye also.

On the following morning he was conscious of a peculiar numbness above the left eye. This numbness gradually spread over the left cheek, and at the same time affected the external and internal surfaces of almost all that side of his head. He lost the sense of taste on the left side of his tongue, and in little more than a fortnight he became deaf in the left ear. Now he complains principally of the inflamed condition of the left eye (which commenced about ten days ago), and of the pain in his left temple.

The above circumstances he himself could relate distinctly. The following is an account of his present condition, April 20.

The left side of his face is drawn towards the right, and is slightly œdematous. The left nostril is collapsed, and does not expand during breathing. The mouth is distorted towards the right side. When he speaks, the two sides of his face are distinctly marked by a line of division; the action of the muscles of the mouth and nostrils, on the right side, being quite distinct, while those on the left are motionless. He has lost all power over the left eye-lids; until lately, he could elevate his upper eye-lid, although, since the time of his first attack, he has always experienced a certain difficulty in closing it. At present the eye-lid hangs down flaccid and shut; he is unable to press the eye-lids together.

The sensibility to touch is gone on the greater part of the left side of his head and face, and this insensibility extends to the vertex of the head.

The surfaces of the conjunctiva and eye-lids are also completely insensible; the eye is inflamed and ulcerated; the left side of the nose, the cheek, the upper and lower lips, are all equally insensible; but he is sensible when touched upon the left side, below the under jaw, and even over the lower jaw itself, as high as the inferior part of the lower lip. The external ear, and likewise the back part of his head, nearly as high up as the vertex, retain their natural sensibility.

The internal surfaces of the left nostril, and of the mouth and gums on the same side, are insensible to touch; and he has neither the sense of taste nor common feeling in this side of the tongue. In consequence of this, portions of food have sometimes lodged within the left side of his mouth, without his being aware of their presence, until they became actually putrid.

The power of moving his tongue is quite perfect: if at rest, it lies in its natural position within the mouth; nor is it dragged towards either side when he is told to move it. Being tickled with a probe on the left side of the root of his tongue, the sensation of nausea and the effort of retching are produced as on the opposite side. He can open and close his jaws; yet it can be observed, when he is made to clench his teeth, or to bite forcibly, that the masseter and temporal muscles of the right side are hard, rigid, and strongly in action, while the same muscles belonging to the opposite side are totally different in that respect, for they feel soft and flaccid.

With regard to his left eye, it has been already noted, that it is deprived of common sensibility, and that he has no power of shutting or raising his eye-lid. Besides these, he possesses no command over the eye-ball: his eye remains fixed and motionless, and directed straight forwards. No motion exists in the pupil when a light is presented to the eye. He has the power of vision, although he sees dimly; this is, probably, on account of the eye being inflamed, and the cornea ulcerated and opaque. When both his eyes are closed, he is sensible of a red light in the left eye, while nothing is visible in the right one *.

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* See remark on this, in the first paper on the motions of the eye.

He was questioned as to the period when he observed that he had lost the power of directing the left eye to objects, but he was unable to inform us, because he had always imagined that the one eye was as much in motion as the other.

August, 1824.—Several of the symptoms of paralysis, both of the portio dura and of the fifth, are become more indistinct; he has regained a little power over the motions of the eye-lids, and of some of the muscles of the face, and the surfaces are endowed with a slight degree of sensibility.

In this case we may observe, that the symptoms show the affection to be limited to the seventh and fifth nerves of the left side, and they best correspond with the supposition, that a disease of the bone, or membranes, has affected these nerves in their course, and is gradually extending forward to the nerves of the orbit.

No. XXXVIII.

Affection of the Nerves of the Face.

A gentleman, of 25 years of age, consulted me on the recommendation of Dr. Cheyne, of Dublin. He begins the history of his complaint so far back as 1825, when he had pains in his head, which came on for two or three hours in the day, and which he attributed to bathing in the river. These pains affected the left temple and side of the nose. They increased insensibly, but were not constant; on the contrary, during his travels they changed so as to make him attribute the variations to the effect of some peculiarity in his place of residence. Thus he left Paris on the 1st of October of that year, and, "strange to say, the pain which afflicted me so severely and constantly, both night and day, suddenly left me before I was twelve miles from Paris, and did not return during that month whilst I remained in London." But when he went home to Ireland, his old pain attacked him with greater violence than before. There were some further irregularities in these attacks of pain. Thus, on one occasion, on taking wine, the pain suddenly left him: on another, while sitting at dinner, the pain became suddenly so severe, as to require persons to hold him in the agony of his sufferings.

In the summer of the second year, having gone to the coast for sea-bathing, the pains increased with a new train of symptoms; his sight frequently became dim for a short time, and things appeared to turn topsy-turvy. Now for the first time he took medical advice: and his surgeon, after acting upon the belief that this was nothing more than the effect of disordered bowels, advised him to go to Dublin, for his jaws became affected. He found, one morning, that they were locked, and says he was obliged to open his mouth with his hands. This spasm gradually went off in the course of the day, and the pain subsided. Next morning he found a great stiffness about his mouth, and felt as if his lips were swoln. "But," he adds, "this was but the commencement of that stiffness which has been my complaint ever since."

In Dublin he had leeches applied, his head was shaved and blistered with tartar-emetic ointment; blisters were applied behind the ears, and he took strong doses of calomel. The medical gentlemen there made him walk, to observe if the motion of his limbs was perfect. At this time he thinks his memory must have been impaired, for although he fell and hurt his arm, yet he so far forgot the circumstance, that his mother had occasion to remind him of it.

He never had any sore throat, nor suppuration in the ear, and never felt any paralytic weakness of the side.

His present condition is this. The expression is almost entirely in the right side of his face. The eye-brow on the left side cannot be knit. The forehead on that side is smooth. The eye-lids do not perfectly close in winking. He can draw up the side of his mouth with the zygomaticus, yet it is with an effort, and less perfectly than on the opposite side. He is not altogether without feeling in this left side of his face; but there is very considerable numbness, and he experiences a scalding sensation in the edge of the tongue, all along to the tip, on the left side. He has perfect motion in the tongue. Its surface is deeply coated. There are no swellings about the ear or jaws.

This gentleman was ordered small doses of salts with sarsaparilla, an application of steam to his ear and side of his neck, and a seton under the occiput. The opinion being, that although suspicion might attach to the state of the bowels, yet an inflammatory attack had certainly injured the roots both of the fifth and seventh nerves. A very careful and regulated diet was enjoined, and hopes were held out, that with these precautions an amelioration would take place in the expression of the countenance.

I shall give here the outline of one or two cases from foreign authors.

No. XXXIX.

" A phthisical patient* had a suppurating tumour on the parotid gland, which exposed the mastoid portion of the digastric muscle. Paralysis of the face came on gradually, and at length the following symptoms presented.

" The eye-ball was perfectly under the control of its muscles. The upper eye-lid could be moved. The lower eye-lid was relaxed and everted. The eye was constantly weeping.

" The nose was dragged to the left side; the nostril of this side remained narrow, while that of the other was dilated by the action of its muscles. The mouth was dragged to the left side. The tongue was perfectly free in its movements.

" When she laughed or spoke, the expression was most strange. On the right side, her face was as that of a dead person, while the left was highly excited. In speaking, we could see the buccinator puffed out and relaxed alternately, like the leather of a pair of bellows.

" Whilst sleeping, the upper eye-lid covered the pupil, while the lower eye-lid was depressed and everted. Some hairs on her upper lip were pulled, which awoke her, and made her complain of being teased.

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* See Descot sur les Affections Locales des Nerfs, p. 318. 1825.—M. Descot published before the translation of these papers into French by M. Genest.

" At her death, respiration was convulsive. The eye-balls rolled in their sockets: the muscles of the left side of her face contracted with force, while those of the right side remained still; and the mouth and nostrils being convulsively pulled towards the left side, a frightful expression of countenance was produced."

There is a minute account of the dissection given; but it is sufficient to say, that a portion of the seventh nerve, corresponding with the breadth of the ulcer, was destroyed; the two ends of the nerve which were thus separated appeared as if teased out.

M. Descot, perfectly candid as to the source from which he takes these views, leaves me under obligation to him.

He remarks, that it is inexplicable how she continued to possess the motion of the upper eye-lid. I would offer this observation. M. Descot having seen two extremities of the divided nerve, it must have been a branch or portion only which was here destroyed. For if the nerve had been destroyed as it makes its exit from the stylo-mastoid foramen, its course before it splits being very short, he might have seen one extremity coming out from the bone: he could not have seen the corresponding end of the nerve, but must have detected many branches. No doubt, therefore, the superior division of the *pes anserinus* had escaped the effect of the inflammation and ulceration. The branches of the portio dura which go along the temple to the upper eye-lid had remained entire: hence the action of the upper eye-lid was perfect, whilst the lower eye-lid, and all the rest of the face, were paralysed. I have stated, that, from an abscess before the ear, I have seen the eye-brow fixed, while all the rest of the face continued in possession of its natural motions: no doubt, because the superior branches only of the diverging nerve were engaged in the disease.

In the same author there is an instance given of destruction of the portio dura, by suppuration in the temporal bone, which was attended with paralysis of the face, and difficulty of swallowing. The latter symptom took place in the case referred to at p. vi. under Dr. Gregory's care. See the System of Anatomy, p. 508, vol. ii.

No. XL.

I select the following quotation from Beclard's notes upon the partial Paralysis of the Face. In these he makes reference to my discoveries, as explained by Mr. Shaw in his paper in the Med. Chir. Trans. 1822. "Il y a quelque mois qu'en enlevant une tumeur carcinomateuse de la région parotidienne droite d'une femme, le tronc du nerf facial fut excisé. Le côté droit de la face est resté paralysé ; mais la paralysie ne devint apparente que dans les mouvemens de la respiration et de la parole : dans tout autre cas elle est à peine apercevable." Descot sur les Affections Locales des Nerfs, p. 313. I would just observe upon this, that many years ago I saw my brother perform this operation with similar effects. At my entreaty, during the operation, instead of cutting out the root of the diseased parotid gland, which would have been attended with a division of the carotid artery, he was induced to apply a ligature around the root of the tumour, which of course included the portio dura. If the branches of the fifth pair were repeatedly cut for the tic douloureux, and the portio dura cut across or encircled with a ligature, without a conception arising in the operator's mind of the functions of these nerves, it brings us forcibly to the conclusion, that it is through the knowledge of the anatomy, and not by what is termed experience, that we are to obtain correct notions of the functions of parts, and more especially of the nerves.

The singularity of the following case is, that without any affection attributable to the condition of the brain, and without loss of sensibility to the face, or loss of motion in the tongue, the functions of the portio dura of the seventh nerve were temporarily interrupted. But the condition of this girl was attended with this remarkable consequence, that she retained her good humour, and sometimes laughed heartily, as it is happily expressed by the narrator, as if behind a mask,—her face being quite immoveable and grave, whilst the emotion and sound of laughter prevailed.

No. XLI.

Syphilis. Paralysie du Nerf facial.—Traitement spécifique. Séton; Vésicatoires.—Guérison.

Salle Saint-Jean, No. 12. Une jeune fille, âgée de 16 ans, grande, bien développée, réglée depuis plus de dixhuit mois, d'une bonne santé habituelle, contracta une blennorrhagie vaginale et urétrale au commencement de Novembre, 1828. Elle ne fit aucun traitement et vint à Paris six semaines après, c'est-à-dire vers le 20 Décembre. Elle portait à cette époque une tumeur peu volumineuse sur la région frontale gauche. Le surlendemain de son arrivée, pendant la nuit, sans douleur préalable, sans cause accidentelle, elle éprouva un engourdissement dans la joue gauche, toute la face de ce côté était raide et insensible, et le matin elle s'aperçut que la bouche était très-fortement déviée à droite. La langue était un peu raide et la parole embarrassée. Il n'y avait du reste aucun autre symptôme.

Un médecin appelé de suite prescrit une saignée de bras, on en pratique une seconde le soir du même jour; des sangsues sont appliquées à l'anus le lendemain, et le tout sans succès. Deux jours après la malade est conduite à l'Hôtel-Dieu.

L'écoulement blennorhagique et l'exostose de la bosse frontale gauche sont constatés, la malade n'éprouve du reste aucun symptôme cérébral ou gastrique. La langue est mobile, sans déviation, et l'on voit que la difficulté de parler résulte de l'immobilité de la joue et des lèvres. Deux jours de suite on administre l'émétique en lavage, le troisième jour on fait une saignée de bras, il n'en résulte aucun changement. On commence alors le traitement anti-syphilitique de M. Dupuytren, qui consiste en pilules composées d'un huitième de grain de deuto-chlorure de mercure, d'un demi-grain d'opium et de deux grains d'extrait de gayac. On donne trois de ces pilules par jour; la malade boit un ou deux pots de décoction de salsepareille avec addition de 4 à 6 onces de sirop sudorifique.

Huit jours après l'apparition de la paralysie à gauche, le même symptôme se manifesta subitement à droite, et la malade en se réveillant n'offrait plus de déviation de la face, mais bien un relâchement complet, une immobilité absolue de tous les traits du visage. Les paupières ne se fermaient qu'à moitié, et les larmes coulaient sur les joues; les lèvres restaient béantes, agitées comme deux drapeux par l'air expiré. La langue n'était pas affectée. Cette paralysie de la face n'avait lieu que pour le mouvement, car la peau et les muqueuses n'avaient rien perdu de leur sensibilité. La malade ne souffrait pas, et sa physionomie habituellement très expressive, conservait alors un caractère sérieux qui contrastait singulièrement avec sa disposition d'esprit. On l'entendait rire aux éclats, mais elle riait comme derrière un masque. Cet état lui causait beaucoup de chagrin.

Le traitement fut continué avec la plus grande régularité. En même temps on appliqua un vésicatoire sur la joue gauche, très-près de l'oreille, on en mit successivement plusieurs autres sur la même région du côté opposé, puis derrière les oreilles; enfin on placa un large séton à la nuque. Il causa beaucoup de douleurs, et ce ne fut qu'au bout d'un mois que la suppuration fût bien établie, que l'on put s'apercevoir de ses bons effets. Au bout de deux mois de traitement, la mobilité des joues reparut peu-à-peu, la malade cessa de dormir la bouche ouverte, les paupières se rapprochèrent de plus en plus et le larmoiement diminua. Il est à remarquer que les sens n'ont jamais été affectés; l'odorat, le goût ont conservé leur finesse. La sensibilité de la peau n'a éprouvé aucun changement.

La santé de cette jeune fille n'a offert aucune altération, son appétit était excellent, cependant elle craignait de manger dans les commencemens de sa maladie parce que les joues immobiles laissaient les alimens s'amasser entre les arcades dentaires et leur face interne, la bouche s'emplissait, sans pouvoir se vider, par la formation et la déglutition du bol alimentaire. Plus tard elle s'habitua à cet état, sa langue, ses doigts et divers instrumens servaient à suppléer l'action des muscles buccinateurs et labiaux.

Ainsi que nous l'avons dit, l'amélioration a été lente, et ce n'est que peu-à-peu que les muscles de la face ont récupéré la faculté de concourir aux phénomènes de la respiration, et de peindre les émotions intérieures. Nous avons vu la malade éternuer sans présenter cette expression de la face, si remarquable dans cette circonstance; elle baillait en abaissant la mâchoire, mais les lèvres et tout le visage, n'indiquaient en aucune manière la sensation qui accompagne l'accomplissement de cet acte. Nul doute que si une circonstance quelconque eût occasionné de la dyspnée, les ailes du nez ne fussent restées immobiles au lieu de se relever et de concourir à cette expression d'angoisse qu'on observe si souvent chez les asthmatiques.

Après quatre mois de séjour à l'Hôtel-Dieu, cette jeune fille est sortie dans l'état suivant. L'exostose de la bosse frontale gauche a disparu, la blennorrhagie est guérie, et la santé générale est excellente. La figure ronde et fraiche exprime avec vivacité toutes les sensations physiques et morales; le rire seul est un peu froid, c'est-à-dire que le mouvement des lèvres ne semble pas correspondre à la rapidité et à l'étendue des mouvemens du diaphragme et des côtes. La mastication est facile et les alimens sont bien réunis en bol. Les paupières se rapprochent complètement, mais il faut un léger effort, et souvent les larmes coulent sur la joue. Le seton est maintenu en place, et tout porte à croire que dans quelques mois il ne restera plus à la malade que le souvenir de cette affection singulière.

Si les belles expériences de Charles Bell sur les usages des nerfs encéphaliques avaient besoin d'être confirmées par des faits cliniques, cette observation serait plus propre qu'aucune autre à démontrer la justesse de son opinion sur les fonctions du nerf facial. On a vu survenir dans cette maladie tous les accidens qui résultent, chez les animaux, de la section de ce nerf à sa sortie du trou stiloïdien. Il est probable que chez elle une exostose légère a comprimé les nerfs à leur sortie du crâne. L'efficacité du traitement anti-syphilitique n'est pas contestable dans ce cas. Les topiques irritans et révulsifs ont achevé la cure; ils étaient indispensables, car souvent après la destruction de la cause qui occasionne une paralysie, ce symptôme a encore besoin d'être combattu par des stimulans locaux.

P. M. *d.-m. P.*

No. XLII.

Consequences of cutting the Portio Dura in operation.

"Dear Sir,—The case to which I alluded in my lecture this morning, as illustrative of your views, was that of a young lady from Scotland, who

had a tumour deep seated behind the angle of the jaw. It was partially, and but partially removed by an eminent surgeon in this town. In performing the operation, the respiratory nerve of the face appears to have been divided, the mouth being drawn to the opposite side to a much greater extent than is common in hemiplegia connected with apoplexy; the ala of the nostril and the whole side of the face participating in the paralytic affection. But the most distressing part of the evil consists in the loss of power over the eye-lids, in consequence of which they cannot be brought together, so that the eye is never properly covered. The tears escape upon the cheek, and there are frequently slight attacks of ophthalmia; or perhaps it would be more correct to say, that some degree of inflammation is always present. The circumstance occurred several years ago, and no improvement whatever has taken place.

" Respectfully and very truly yours,

" R. MACLEOD.

" January 17th."

No. XLIII.

Case of Paralysis of the Face.

In M. le Professeur Roux, of Paris; communicated by himself to M. Descot.

" I have for many years been subject to rheumatism, which has most commonly been seated in the loins. In the month of October, 1821, I was attacked with paralysis of the right side of my face. I am not aware of having been exposed to any influence which was likely to excite rheumatic disposition in the muscles or nerves of the face; but it appears from the circumstance of the muscles being paralysed that some irritation has existed, probably a rheumatic irritation of the facial nerve. When the paralysis was complete, I began to feel pain in the temple, and there was œdematous swelling in the part. During the course of this complaint I have experienced two circumstances which may lead to the detection of the facial nerve becoming affected. 1. The membrane of the tympanum was painfully sensible even to slight noises. 2. The sense of taste was affected in the right side of the tongue, so that every thing tasted metallic.

This last symptom has even been a precursor of the complaint, being observed twenty-four hours before the occurrence of paralysis. In other respects, little pain was experienced, even in the trunk or the branches of the facial nerve. There has been no diminution of the sensibility in the skin of the face. The paralysis of the occipito frontalis muscle, of the orbicularis palpebrarum, and of all the muscles of the lips, on the right side, was complete. I have been like a patient who has hemiplegia, pronouncing words imperfectly, unable to blow with my mouth, laughing only on one side, feeling an inconvenience in eating, from want of action in the buccinator, deprived of the power to close my eye-lids," &c.

This complaint ceased gradually as it began, yet rather more slowly.

This is the sort of case which is apt to throw the pathologist into difficulty, and therefore we shall give it some consideration.

The sensibility evinced in the ear indicates an inflammation in the course of the portio dura, or at least an affection commencing there, and by influencing the trunk of the nerve, producing the paralysis of the face. I have stated why the respiratory nerve of the face, and the sensitive nerve, take different routes to their destination; but it is not to be supposed that the sensibilities and motions of the face are in any degree more independent of each other than those of the arm, or any other part of the body. Accordingly, irritation and pain produce in the face what irritation and pain may do in any other part of the body. I would only suggest to the observer, that he should distinguish those motions which are expressive of pain from those which are spasmodic and incontrollable[*]. This will be especially necessary in studying the disease called tic douloureux.

No. XLIV.

Case of Trismus, conjoined with Paralysis of the Face.

Thomas Jones, æt. 29, a groom, was admitted into the Middlesex hospital under Mr. Bell's care, October 10th: he complained of a painful stiffness in his jaws, and the muscles of one side of his face were paralysed. He stated that, on the last day of September, while dressing his horse, it struck him with the fore-foot upon the right side of his head, and knocked him down. He remained insensible for some time. When he returned to consciousness he felt weak, and a little sick. There was a wound, as if made by the heel of the shoe, just over the external angular process of the frontal bone. Nothing however was done for him, and he lived as usual. It was mentioned by his master that he was much given to drinking, and that at one time his head and hand trembled from its effect like an old person's. On the fourth day after the accident he first perceived that his face was twisted to one side; he then had also some difficulty in speaking and swallowing. It was not till the 6th October that he consulted a medical man, who recommended him to come to the hospital.

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[*] We find *trismus* and *tic* as a title; diseases quite distinct classed together.

The face is twisted to the left side, as in the cases of partial paralysis from injury to the portio dura of the seventh pair of nerves; and this distortion of the face is most observable when he speaks. Upon being asked to close his eyes, the left is shut, but the eye-lids of the right side are very imperfectly closed, and in the attempt the cornea is turned up. The feeling on the right side of the face is as perfect as on the left. It cannot be perceived how far the motion of the tongue is impeded, as he cannot open his mouth freely: he is apt to bite both his tongue and cheek while eating. The wound on the side of the orbit resembles a mere scratch, nearly healed. There was no bleeding from the ear after the accident, and he hears perfectly with both ears. There is a fulness and rigidity about the masseter muscle on the right side, and Mr. Bell thought there was a preternatural swelling before the right ear.

Hirudines, xii. ante aurem.

Pil. Colocynth. cum Calomel. gr. x. statim, et mane haustus purgans. Lotio Plumbi Acet. cum Opio ad partem dolentem.

11th Oct.—The house surgeon was called in the morning to this patient, as it was reported he was seized with a fit. He found him struggling like one who is suffocated. He seemed to labour from a difficulty of expectoration; his jaws were firmly clenched; his face was livid; the muscles on the right side were relaxed and drawn to the left side; those of the neck were rigid, and in strong action. It required the power of two men to restrain him in bed. Two drachms of the tincture of opium were administered in small quantities between his teeth, after which the fit left him. He was quite sensible during it, and called it an attack of the cramp. To-day his jaws are more firmly closed. He complains of a pain at the back of his neck, as if something were dragging or pinching him there. His bowels have been opened. Pulse 110, and firm.

Cucurb. cruent. occipiti.
Hydrarg. Submur. gr. x.
Tinctura Opii, ʒss. 3tiis horis.

12th Oct.—The patient to-day was visited by Drs. Latham, Watson, and Hawkins. The teeth are more closed. The attempt to swallow brings on violent convulsions in his throat and chest; he refuses to take any drink, and he has not taken his medicines, from the fear of bringing on these attacks. The suffering of which he complains most is from the phlegm in his throat, which makes him cough, and he throws out his saliva as in hydrophobia. During the paroxysms he starts up in bed; and we find him now sitting on the side of it, unwilling to lie down, as he is afraid of a recurrence of the fits.

Capiat Hydrarg. Submur. gr. x.
Enema Opii.
Cucurb. cruent. nuchæ ad ℥x.
Descendat in baln. calid.
Cataplasma cum Lotione Plumb. Acet. cum Opio ad vulnus.
℞ Extract. Tabaci. Unguent. Hydrarg. part. æqual. fiat Unguentum. This ointment to be rubbed upon the neck and jaws.

13th.—Yesterday he was put into the warm-bath, which was followed by a copious perspiration, and he expressed himself relieved by it. The fits attacked him four or five times during the day, and they continued about five minutes each time. He was unable to speak during them. His head was thrown back and his chin was tilted up, but not so much as to be called opisthotonos. He has never complained of spasms in his epigastrium. He possessed a perfect command over his arms, legs, and head; but he had convulsive twitchings as he lay in bed. About seven in the evening his jaw began to be relaxed, but this was accompanied with evident symptoms of approaching dissolution. He sunk gradually, after having had severe fits, and died this morning at ten o'clock.

Examination, 24 hours after death.—The features were distorted, as during life. The right eye was wide open, while the left was shut. The cicatrix on the side of the head was examined, but nothing appeared to indicate any morbid condition of the parts in its neighbourhood; the skin only seemed to have been divided. The fibres of the orbicularis palpebrarum, which were under the cicatrix, seemed natural, and the bone was not injured. The parotid gland was in a healthy condition. When the branches of the supra orbital nerve and those of the portio dura were minutely traced towards the wound, nothing remarkable could be observed in them. There was a small gland, not bigger than a field bean, imbedded in the substance of the parotid gland, and lying in contact with the portio dura. When this was cut into, it was found to contain a little purulent matter, but the nerve was not adherent to it, and did not seem altered in its structure. When the brain was examined, the tunica arachnoidea was found slightly opaque, and the veins were more turgid with blood than natural. There was also some serum in the ventricles, but in other respects, on a close examination of this organ, and of the nerves coming from it, the appearances were perfectly healthy. The roots of the fifth pair of nerves, and the course of the portio dura through the temporal bone, on the right side, were carefully examined, without detecting any alteration from their natural structure. The spinal marrow seemed healthy. The nerves of the sympathetic system (in the abdomen and the chest) were examined, without discovering any thing preternatural. The viscera, both of the thorax and abdomen, were in a healthy state, and the lungs were not more gorged with blood than is common. The glandulæ truncatæ at the root of the tongue were enlarged, but there was no redness marking inflammation either in the fauces, larynx, or œsophagus.

Mr. Bell, in his observations on this case, first remarked its resemblance to some cases of partial paralysis of the face, in which he had been consulted during the present season. He admitted that the incapacity of closing the eye, and the total loss of motion of the lips and cheek on one side, deceived him when he first saw this patient in the waiting-room.

The anomaly of the case was, that on the side where the hurt had been received, the exterior muscles of the face, all those influenced by the portio dura were in a state of paralysis; whilst the muscles of the jaws, supplied by the fifth pair, were in a state of tetanic spasm. He related a case of paralysis of the muscles of the face on one side, produced by a blow upon the head; but he added, that, in the present case, on looking retrospectively, there was no reason to suppose the symptoms referrible to an injury of the brain, much less to an injury of the nerve passing through the bone; it was, he conceived, a case of trismus, arising from the slight bruise of the integuments of the temple operating upon a constitution morbidly predisposed. The only peculiarity was the partial paralysis: he could not charge his memory, at that time, with another case where this symptom was combined with trismus. A. S.

No. XLV.

Disease of the Portio Dura extending to the Fifth.

" Stephen's Green, May 7, 1827.

" My Dear Sir,—It is high time for me to thank you for your kindness in sending me your last publication on the Nerves, which clearly illustrates your notions of the functions of the various parts of this system, and which must directly lead to a new and useful line of treating some of the diseases of that system.

" Permit me to trouble you with the outlines of a case at present under my care, which present a combination of symptoms not often met with.

" Mr. S——, about eighteen months ago, suffered severely from pain in the occiput and back of the neck. This suddenly and unaccountably left him, and again returned in August last. About the middle of October, he was affected with paralysis of the left side of the face, attended with a slight dilatation of the pupil of the left eye, an inability to close the eyelids, and, agreeably to your account of such cases, with the turning up of the eye-ball when he attempts to close the lids. On the attack of paralysis, the pain of the occiput and neck ceased, but returned again with great severity, and without any assignable cause, early in January. By the exhibition of calomel, to the extent of nine grains a day, the pain was removed, and, with it, giddiness, great weakness of the limbs, nausea, and loss of appetite; which symptoms had attended the recurrence of the pain. This attack, however, left after it a new and distressing symptom.

" Mr. S. now complained of great coldness in the affected side of the face, of a total want of feeling in this part, of want of taste in the left side of the tongue, and of such imperfection in chewing, that he repeatedly pinched his cheek between the molares teeth when he attempted to chew at this side.

" Mr. S., about four weeks ago, had another attack, equally severe with either of the former, and attended with extreme weakness of the limbs, with more of giddiness, of vomiting, and more complete loss of appetite. In this attack he lost flesh most rapidly. Again the use of calomel, with a small caustic issue to the occiput, has restored him to tolerably good health; the insensibility of the face and tongue remaining as it had been after the second attack of pain. It may not be amiss to add, that Mr. S. had been repeatedly subject to a purulent discharge from the left ear. Should any remarkable change take place in this case, I shall be happy to communicate it to you, if you think it worthy of your attention.

" Believe me, dear Sir,
" Yours very sincerely,
" A. Colles."

No. XLVI.

Dissection which shows the Portio Dura compressed by a Diseased Gland.

" Few opportunities have as yet occurred of ascertaining the condition of the nerve in those interesting cases of local paralysis which have been so beautifully illustrated by Mr. Charles Bell and his lamented friend the late Mr. Shaw. It is probable that there is either an inflammatory action in the nerve itself or its coverings; or that the nerve is affected by disease of some of the parts through which it passes. The only case in which I have had an opportunity of examining the parts, since I was acquainted with the discoveries of Mr. Bell, was lately, in a woman about forty years of age, who died of organic disease of the stomach. About a fortnight before her death, she was seized with twisting of the mouth and paralysis of the orbicularis of the left eye. She had afterwards considerable indistinctness of speech, and before her death there was inflammation of the left eye, with an evident tendency to sloughing of the cornea. A small hard tumour was felt under the ear, deeply seated betwixt the angle of the jaw and the mastoid process. On dissection, no disease could be discovered in the brain. The tumour under the ear was found to be of the size of a small bean, very firm, of an ash colour, and when cut across, it discharged thin puriform sanious fluid from minute cells in its substance. It lay directly above the facial branch of the portio dura, and there was considerable appearance of inflammation in the cellular membrane surrounding the nerve; but I could not discover any deviation from the healthy structure in the nerve itself. I thought it was diminished in size at the place where the tumour lay over it; but in this I might be mistaken."—*Pathological and Practical Researches on the Diseases of the Brain and Spinal Cord, by Dr. Abercrombie*, p. 415.

No. XLVII.

" Stamford, 10th July, 1829.

" Sir,—Mr. ———, who will deliver this to you, became a month since affected with paralysis of the muscles of the left side of the face. This affection had been preceded by pain near the foramen stylo-mastoideum and parotid gland, but not so severe as to excite much attention from the patient, till questioned on the subject. That the mischief was in the course of the nerve, and not at its origin, was indicated by the absence of all symptoms that might be referred to the brain, and by the portio mollis not being affected. The treatment, therefore, was directed by the principles laid down by Mr. Shaw, founded on your discovery respecting the use of the nerves, and the truth of which these cases so strikingly illustrate. The muscles have lost their power, but retain the sense of feeling, because that is transmitted by another nerve.

"I have applied blisters and leeches behind the ear, and over the parotid gland, attention being paid to the state of the primæ viæ: the parts affected have been well rubbed with a stimulating embrocation. I was about to apply the cupping glasses behind the ear, and to have recourse again to the leeches and blisters, in concurrence with the opinion of Mr. Cooper, of this place. The patient being called to town, I am desirous that he should avail himself of the opportunity of obtaining your opinion, and which he is anxious to do.

"I am, Sir,
"Your obedient servant,
"Edw. Hatfield.

"*To Charles Bell, Esq.*"

No. XLVIII.

"*Soho Square, 14th July.*

"Dear Sir,—I have made an accurate examination of your patient's symptoms, and I think your diagnosis correct. The face is twisted to the left side. The right nostril does not move in respiration. The eye-lids of the left side are not closed when he winks, although, when he attempts it, the eye-ball is turned up, the cheek is relaxed, and the forehead on the left side unruffled. These are all symptoms of compression on the portio dura. I find no discharge from the ear. There is no reason to apprehend affection of the brain; and, lastly, just between the mastoid process and the upright portion of the lower jaw, I find an enlarged gland, which is tender on pressure. I hope, therefore, sir, you will proceed to fulfil your intentions:

"1st, By the application of leeches behind the ear.

"2d, By steaming the side of the head and of the neck with vinegar and water.

"3d, By the use of a stimulating embrocation or liniment.

"I would commence with a smart dose of calomel and scammony, and continue to give an alterative dose of the blue pill at night, with a cupful of decoction of sarsaparilla and lime water, in equal parts, twice a day.

"I am of opinion that your patient will get quite well, and I shall have pleasure in hearing from you.

"I am, dear Sir,
"Your very obedient servant,
"Charles Bell."

By a letter of the 18th August, Mr. Hatfield gives an account of his patient's gradual amendment.

No. XLIX.

The symptoms of the following case, in which I was consulted, are by no means uncommon. A gentleman returning from hunting was thrown; he lacerated his scalp, and suffered concussion. He lost a great quantity of blood, was reduced very low, and remained subject to an affection of his head, which after years has returned at intervals. It will come on in consequence of the conversation, heat, and light of a dinner party, even although he does not exceed; and on other occasions any direct disturbance of the stomach will produce it. He has headache and pain along the course of the nerves on one side of the head, a tenderness and indescribable sensation on the scalp, a puffing of all that side of the face, and swelling of the eye-lids of the same side. This after a day or two, by rest and evacuations, subsides. Still he becomes liable to it on any excitement of the mind, or derangement of the digestive organs.

Such attacks, as I have said, are not unfrequent; and it is only when the puffiness and sensibility affect the seventh nerve that the paralytic affection comes on. Morbid sensibility and tumefaction result from the affection of the fifth, and form the primary class of symptoms. The seventh nerve partaking of the influence, palsy of the corresponding muscles is thus in a secondary way produced; while, by an indiscriminating observer, the pain and the paralysis are attributed to the affection of the same nerve.

No. L.

Many years ago, I was sent for early in the morning to Lord ———, who had suffered all the tortures of the *tic douloureux,* and had submitted to have the nerve of the cheek (the suborbital branch of the fifth) divided by Mr. Pearson. He had been brought suddenly, from the severity of pain, and the recommendation of his medical advisers, to the resolution of submitting to the division of the frontal branch of the fifth nerve.

I performed the operation, marking the notch in the frontal bone, and drawing my scalpel along the inside of the orbitary ridge. What I remarked, with some misgiving of my own precision, was that no effect was produced on the motions of the forehead and eye-brow, which made me a second and third time draw my knife across the course of the nerve, &c. down to the bone; but no paralysis of the muscles took place. Neither had paralysis of the muscles of the cheek followed the former operation on the second division of the fifth nerve. I treasured these circumstances long in my mind before they led to any formal conclusion.

No. LI.

"Chatham Barracks, Sept. 13th, 1828.

"Dear Sir,—The following case, which came under my own observation at the time of its occurrence, struck me as being illustrative of your theory of the nervous system; and as I have watched the progress of your discoveries in that branch of physiology, while a pupil in Windmill-street, with much interest, I feel that I am but performing a duty in transmitting it to you.

"While the British troops were quartered in Portugal last March, Lieut. ——— fell with considerable force from the top to the bottom of a flight of stairs, having missed his step in the dark, when the left side of his face struck with violence against a flag. On seeing him some hours after the accident, I found that all that side of his head and face was much swollen and bruised; he complained of headache and a numbness of the face. I bled him at the time, and ordered aperients and fomentations to the part injured. When the symptoms of injury of the head had disappeared, and the swelling had abated, he continued to complain of numbness of the left side of the face, extending from just below the orbit, along the ala nasi to the tip of the nose, and to the upper lip, exactly as far as the centre of its depression, corresponding precisely with the distribution of the facial division of the second branch of the fifth pair of nerves.

" On searching for the cause, I readily found that the margin of the infra-orbitary foramen, formed by the superior maxillary bone, was broken off, causing a sharp spicula which presses on the nerve, or has divided it at the very point of its exit upon the face.

" It is now six months since the accident, and the side of his face is still quite insensible to the touch, or even when gently pricked with a sharp point; the razor skims over the left side of his upper lip unfelt, and when he applies a vessel to his mouth, a sensation is imparted as if its edge were broken off at the part which touches the affected lip.

" The expression of his countenance is not at all affected, for when he speaks, laughs, or sneezes, the muscles of both sides act in perfect unison.

" I am, dear Sir, yours very truly and respectfully,

" John J. Russell.

Memb. Col. Surg. and
Assist. Surg. 63d Regt.

" *Chas. Bell, Esq. London.*"

I have noticed, in the text, the effect of injury of the third division of the fifth or mandibulo-labralis to be the insensibility of the corresponding portion of the lip, which, with these two last cases, complete the proofs drawn from experience in the human body, that the sensibility of the face results from the three facial branches of the fifth pair.

No. LII.

Affection of the fifth Pair of Nerves.

"21st October, 1822.

"L. A., a healthy girl about twenty, received seven years ago a blow from a stick on the right eye. The blow must have been severe, as her eye was blood-shot, and could not be opened for several days. From this time she thought the sight never was so good as in the other eye. About four years since the dimness increased, but she could still distinguish small objects, till June last, when she was affected with a pain in the right ear, deafness, and a discharge. About the same time she suffered from severe headaches, affecting only the right side, and, soon after, she lost the sight of the eye altogether. The motion of the iris remained perfect, but she felt a dull pain at the internal canthus, which seldom abated, and at times there was a copious flowing of tears. Things continued in this state for about two months, when the pain and discharge from the ear ceased, and in a few days more the surface of the eye became perfectly insensible to the touch. This loss of feeling extended to the lining of the eye-lids, to the skin covering them, and to the skin on the cheek and forehead for about an inch surrounding the eye; it did not go beyond the middle line of the face. When she told me that her eye was *dead,* as she expressed it, to be certain, I drew my finger over its surface, and so far was this from giving her pain, that she assured me, she could not feel that I was touching it at all. The eye-lids made no effort to close while I was doing this, but the conjunctiva appeared sensible to the stimulus, as a number of vessels on the surface of the eye became immediately injected with blood. At this time a perpetual blister was applied behind the ear, and 2 grs. of calomel given night and morning, with a view of affecting her mouth. After a few days, however, the pain in the ear came on, with increased deafness, but scarcely any discharge; and at the same time the sensibility of the eye and surrounding skin returned, and has continued ever since. The sight is totally gone, but she suffers no other inconvenience, excepting the partial headaches, and at times the pain at the inner corner of the eye.

She has had throughout a perfect command over the muscles of the eye and eye-lids, and can shut the latter completely. There has been no affection whatever of the muscles of the face.

"November 21st, 1822.

"On the 25th October late at night, she was found lying on the stairs in a fit. She recovered after some time, but the fit, with violent convulsions, returned at intervals through the night. From the description given, the fits were not epileptic, but well-marked hysteria attended with the globus, flow of urine, and peculiar affection of mind. I saw her early on the 26th. She had insisted on being dressed, and declared she was quite well. She acknowledged, however, that the headache (hitherto confined to the right side) was now general. Her answers were tolerably coherent, but given in a childish petulant manner. The state of the eye was unchanged. Her pulse was 80, full and strong. She had menstruated a fortnight before, and had always been regular in that respect. I bled her very largely, had her hair removed, and a cold embrocation constantly applied to the vertex; she was also well purged with salts and senna, her feet bathed, and she was confined to bed in a dark room.

"27th.—She appeared more collected in her mind, but had still the diffused headache. Pulse reduced in strength. She got the senna mixture again, and a large blister was applied to the nape of the neck.

"28th.—Her head much better. Her mind quite tranquil. Pers^{t}. in usu embrocationis, necnon Mist. Cath^{æ}. et pediluvii.

"29th.—Headache quite gone; apparently free from complaint."

"Notwithstanding these favourable appearances, I still apprehended that an organic disease might be extending itself in the head, and as the hysteria, from her very full habit, was evidently connected with plethora, I continued the purgatives daily, kept her confined to bed, and on the very lowest regimen."

"November 2d.—She told me that she had felt all night as if there was sand in the blind eye, and sometimes sparks of fire seemed to pass through it. There was no change in the appearance of the eye. On the 3d, when she awoke, these sensations were gone, but she was agreeably surprised to find that her sight was restored. When the left eye was closed, she could see large objects very distinctly with the right, but could not read or discern any thing very small.

"On the 4th, she could read small print, and since that time has continued perfectly well. The sight, she thinks, is not quite so good as in the left eye, but pretty much as it has been since she received the hurt.

"Whatever was the nature of this injury, it appears to have only given the predisposition to disease. The gradual manner in which the sight was lost, and its sudden recovery when her system was reduced by severe evacuation, point out the connexion of her complaint with the increasing fullness of her habit. Notwithstanding the coincidence of pain and discharge from her ear, her case is evidently different from those described by Mr. Bell. The only nerves affected appear to have been the optic, and, at one time, the first branch of the fifth pair; and there was no muscular affection whatever. Her ear had been quite well for some time before this last illness.

"Nov. 16th, 1822."

No. LIII.

Short Abstract of a Case of Disease of the Fifth Nerve.

(From Descot, p. 316.)

It appears that MM. Serres, Majendie, Lisfranc, and Georget were present at the dissection of this case, and that the following circumstances were stated previous to the operation. The patient had been epileptic; for six months there had been inflammation of the eye, coarctation of the pupil, and opacity of the cornea; the conjunctiva was insensible to a feather; the nostril of the same side was insensible; sulphat of quinine was not tasted on the side of the tongue; the gums were spongy, dark-coloured, and detached from the bone; the hearing was very dull on the right side; the patient could chew perfectly well.

On dissection the fifth nerve of the side affected was remarkably altered. At its origin it was found soft, yellowish, and reduced almost to a jelly; and this derangement could be traced two lines into the tuber annulare. The nerve, traced forwards, exhibited the same soft, yellowish appearance, excepting the muscular portion, which was natural. The diseased nerve was a line and a half less in diameter than that of the sound side.

I must remind the reader, that, at the time of this dissection, M. Majendie had proclaimed a discovery, than which nothing could be less founded in reason. I had proved that the sensibility of the head and face resulted from the fifth pair; but he asserted that vision, smelling, and hearing, were bestowed through the operation of the fifth pair; and the above dissection was declared to confirm the truth of his discovery *.

Had this assertion been correct, it would have been a severe blow to the students of anatomy. They trace the optic nerve into the eye, the olfactory nerve to the membrane of the nose, and the auditory nerve to the cavities of the ear. But what availed all this, if the French physiologist had proved, instead of the first, second, and seventh nerves, that the fifth was the nerve of smelling, seeing, and hearing?

But, as I have explained in the text, the fifth nerve bestowing sensibility, and that sensibility being the safe-guard upon the organs, we cannot be surprised that those organs should, in the absence of their natural guardian, be irritated and inflamed, and consequently deranged by the disease of the fifth nerve.

This is especially true of the eye. I have taken great pains to explain the apparatus by which it is protected, and the sensibility which excites that apparatus into operation; but when the sensibility is withdrawn, the apparatus is useless, and the eye becomes inflamed by irritation.

I have noticed in the text the difference between the sensibility of the interior membranes of the nose and the power of smelling; the one depending upon the fifth, and the other upon the first nerve. I have also shown that the common sensibility of the nostril was that which excited to sneezing and blowing the nose, and that these actions were to the

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* "Cette coincidence d'une lesion du nerf trijumeau, avec l'altération de l'œil et des gencives, la perte de l'action des sens, est d'autant plus curieux qu'elle confirme les résultats obtenus par M. Majendie par la section des nerfs de la cinquième paire."

nostrils what winking is to the eye, the means of removing whatever is irritating or offensive.

But I need make no further observations upon this case; it will be understood, in all its bearings, upon perusal of the preceding papers.

No. LIV.

Affection of the Muscles of the Jaw.

I have, in my first, fourth, and fifth papers delivered to the Royal Society, noticed, that the muscles of the jaw are supplied by the fifth pair, a cerebral and voluntary nerve, whilst the muscles of the face, properly, are moved by the *portio dura,* a respiratory nerve. The affections of the latter are very common, of the former more rare, unless in disease of the brain, or in the instance of tetanus.

A gentleman brought his daughter to me: the account he gave would have induced me to believe the case an aneurism rather than an affection of the nerve, there was so much talk of swelling and pulsation. I gave the following *opinion:*—There are, in this lady's case, two distinct subjects of consideration. The swellings to which the side of the head is subject arise from occasional violent spasmodic states of the muscles of the jaw on the left side; the masseter is, from time to time, brought powerfully into action, so as to present to the touch a round hard ball. The temporal muscle, which lies on the side of the head, is subject to alternate actions and relaxations which resemble pulsations.

The second point must be separated. The upper and lower jaws on the left side are deficient in growth. The cause of this defect of growth is very obscure, and the influence, of whatever nature, must have struck and had its effect nine years ago, in childhood. It is beyond control.

The first object will be to remove the local mischief in the sensibility of the gums; and the second indication is to remove, if possible, any source of irritation that may be in the uterine or digestive organs.

This lady returned, about two years and a half after this report, with her mother, who had a nervous affection of the eye: she had not met with any relief in all that time, and despaired of being cured. Its long continuance, however, did not bear me out in my first opinion, that it depended on the state of the gums, but rather on some more permanent disorder of function.

No. LV.

Case of Disease of the Nerves within the Orbit.

Martha Symmonds, æt. 41, Northumberland ward. This woman was admitted into the hospital for a disease apparently seated in the left orbit. Nine months ago she had a paralytic stroke, attended with the loss of power in her right arm, and she lost the sensation of the arm, neck, and face, on the same side. She lost, also, her power of speech, excepting only to "babble," as she says. She recovered from this attack, and went into service. About eight or ten weeks ago she was alarmed by a commencing dimness in both her eyes, and she was obliged to leave her place on account of this dimness of her sight. Both her eyes were equally affected, and there was no redness or opacity perceptible in either of them. She placed herself under a medical gentleman because she dreaded a return of the palsy. About six weeks ago the upper eye-lid of the left eye fell, and she could not raise it. At that time she suffered great pain above the left eye, and the pain extended upon the left side of her forehead. She at the same time lost the vision of this eye, although she could distinguish by it the light of day from darkness. She could direct the motions of this eye-ball as well as of the other at that time, and the appearance of the eye was natural.

Five days before she was admitted into the hospital, she experienced a violent deep throbbing pain in her left eye, and from that time the eye-ball, as she says, became enlarged, until it projected considerably beyond the orbit. Two days before her admittance she was totally blind in that eye, and was deprived of sensation on the surface of the whole eye, eye-lids, the internal corner of the nose, and upon the left side of her forehead.

At present her left eye is covered with its upper eye-lid, and projects greatly from its natural situation. The lower eye-lid is everted, as a consequence of the projection of the ball of the eye, and the conjunctiva is tumid and projecting. She cannot raise the upper eye-lid, although, when it is raised with her finger, she can squeeze it down again, and winks with a motion which corresponds naturally with that of the other eye. It may be a question, whether the globe of the eye is enlarged or only protruded. The pupil is unnaturally large, and the iris is without motion. She cannot move the eye-ball in any direction. The whole eye is insensible: she has just had her lower eye-lid scarified, and she was not sensible of pain. She allows us also to press with our finger on the surface of the eye without complaining of any pain, or winking; although, as we said above, she can still wink, and does wink with this eye-lid when the other eye is threatened.

Oct. 6.—To-day some further examination was made of this woman's face and head in order to ascertain the extent of insensibility. It was stated in our last report that she has lost sensation in the surface of the left eye and eye-lids, in the corner of her nose, and upon the forehead. In these parts, she says that now the loss of sensation is less complete, because, when she had her eye-lid scarified the other day, she felt pain, which she did not when it was scarified before. The eye also seems diminished in size.

Besides those parts which we have already described as being affected, she has, in a partial degree, lost sensibility to touch in that part of her cheek which is just under the orbit, and downwards upon the side of her nose, and upon the left side of her upper lip, and also within the cavity of the nose on the left side. However, when the point of the pin was brought near to the ear, or upon the skin which is over the lower jaw, she then was sensible of pain. A piece of linen was twisted so that it might be introduced into the left nostril: she allowed us to push it upwards as far as we could, and during this operation she only observed, that she was sensible of its presence. Turning it about within her nostril did not make her sneeze. When we tried the same experiment on the other nostril, she was unable to bear the tickling produced by the loose threads of the cloth, before it was introduced into the nostril. Now she informed us that she is in the habit of taking snuff; and she is not only insensible to its usual agreeable effects, but unconscious of its presence in the left side of the nose. We next made her close her right nostril, and inhale strong spirit of ammonia; and then repeated the same experiment on the other nostril. There was a very obvious difference in the effects produced by the ammonia on the two sides of her nose. She told us she could smell the ammonia on both sides; but still she could not bear to hold the bottle containing the ammonia so long at the right nostril as we observed that she could at her left. When the bottle was placed under the right nostril, its pungency affected her almost immediately, so much that she could not bear it; on the other hand, she allowed it to remain for a considerable time under the left nostril, and even snuffed it up strongly before she was inclined to remove it. During these experiments we observed that the right eye became suffused with tears; the left eye, on the contrary, appeared to be dry in its surface.

In order to ascertain further to what degree her sense of smelling was affected, we tried the effect of some substances which possess odour without pungency. On applying oil of anise-seed to her left nostril, while the right one was shut, she inhaled it powerfully, but was sensible of no smell. Then a piece of asafœtida was tried, but still she had no kind of sensation, either pleasant or the reverse. She was sensible to these odours on her right nostril.

The state of her mouth was examined; with the point of a pencil we pressed against the upper gums, on the left side of her mouth, and the inside of her cheek, where it is reflected off the gums, and she appeared to have either very slight or no sensation at all. She volunteered to put a spoonful of mustard between her gums and her cheek; and she seemed very little incommoded by such an experiment. The sensibility of the other parts of her mouth was natural.

The circumstances of this case make it difficult to determine exactly, where the disease is seated, which thus produces the destruction of the optic nerve, the third and fourth nerve, the first and second divisions of the fifth nerve, and the sixth nerve. Among these nerves we might add the olfactory nerve; but it may be made a question whether the function of that nerve is directly or indirectly affected: the issue of the case will probably determine this matter. However, from the condition of the parts without the orbit, we observe, that the power of closing the eye-lid, and of winking, is retained, when the power of raising the eye-lid is gone, and the sensibility of the eye-lids, and of the eye itself, is completely lost. It is the portio dura which is distributed to the orbicular muscle of the eye-lid, and bestows the power of winking. We see, likewise, that she can inhale powerfully, and can perfectly move the muscles belonging to the nostril and upper lip of the left side, when at the same time the skin which covers these parts is insensible. Still that power belongs to the portio dura. This nerve, passing to the face by a circuitous way, and being therefore uninjured by pressure within the orbit, permits her to move the left nostril and the side of her mouth in a natural correspondence with the other side of her face, although both the first and second divisions of the fifth nerve are included in the disease, and are destroyed along with the first, second, third, fourth, and sixth nerves.

May 20th, 1829.—Since she left the hospital she has been a constant sufferer. The pain in her head has never left her; it is principally seated over both her eyes, and over the left in particular. For three years she has observed that this pain is aggravated for a fortnight before her monthly periodical return; she says she does not know what to do, her suffering is so great. The pain varies in a remarkable manner with the changes of the weather; she knows when rain is approaching by the increase of the pain, and immediately after it is over, the pain is relieved. She has not had a return of the loss of speech, or of the paralysis of her arm, since she left the hospital, but she has had fits, and she has suffered from cramps in the back of her neck and right breast. The arm which was formerly paralytic, becomes about once a month numbed in such a manner that she cannot use her fingers, and this is accompanied with great pain; these attacks do not last for more than five minutes. She walks quite well.

The loss of sensation is principally in the forehead: when pricked with a sharp point in any part as high up as the crown of the head, she had no feeling; but in the temples and below the orbits, and on the nose, she retains sensation. The left eye is blind; the pupil large and immoveable; the motions of it are gone; the surface is insensible; it is clear, and it remains fixed in the centre of the orbit.

No. LVI.

Of painful Affections of the Face from Disease of the Fifth Nerve.

The sympathetic pains, produced by internal irritation, are continually calling for the attention of the physician, and some of the most distressing cases we witness belong to this class of disorders. I shall not dwell on the instances of external pain regularly produced; such as those of the mammæ in women, of the arms, shoulder, or back, of the hips and hams, in disorders of the head, &c., lungs and stomach, or of the colon, kidneys, uterus, &c. These affections are of every day's occurrence, and well deserve attention, but we must circumscribe ourselves here to the disorders illustrative of the true anatomy of the nervous system, and which are explained by the study of that system.

I am of opinion that the disease called tic douloureux has its source in visceral irritation, communicated through the sympathetic nerve. That nerve, we have seen, is universally connected with the nerves of the arms and lower extremities, as well as with those of the head. The disease takes place in the extremities as well as in the head; I have seen its effects in the toe and in the finger.

In the painful affection of the face there is often a symptom which I may say I recognize as proceeding from intestinal irritation, I mean the sensation of scalding. This sensation of scalding is very common in the lower extremities. A purgative in its progress through the canal will sometimes be attended with this sensation, but often will happily remove it. I have a patient who, on any accumulation of irritating matter collected in the intestines, will have a severe scalding sensation from the hip to the heel. This affection is attended with tenderness on pressure, and if permitted to continue will assume the character of sciatica. The degree of severity to which this painful affection of the limb will extend is very surprising; I attended a lady who described to me her sufferings in very animated language:—a scalding and burning pain extending down the back part of the thigh; she could not rest in bed, but remained on her knees by the side of the bed; she took five hundred drops of laudanum in the night, another indication of the severity of her suffering. In this condition she had been for several years. After visiting her two or three times, I prevailed upon her to let me see the part affected, for I had imagined she had some severe cancerous ulceration, but on the hip and thigh, and leg, the seat as I supposed of this cutaneous ulceration, there was not the slightest discoloration, there was, in short, no disease there; nor was there any defect at all, for although she had been for years confined to her bed, on some alarm of fire from the smell of smoke in the night, she was the first of the family on the stairs! But my purpose is not to fill my pages with these cases, but to restrict myself to the fifth pair.

The painful affection of the face called tic douloureux is seated in the fifth pair, and for the most part in the second division of this trigeminus nerve; and so convinced am I that it is the more direct connexion established betwixt the sympathetic nerve and the fifth that produces this pain, that I could wish to divide the sympathetic in the neck, if I thought I could do it with safety.

The pain of this disease is inexpressibly severe. In the note of the case from which I now quote, the paroxysm begins with much sneezing, and itching of the side of the forehead: the pain begins at six o'clock, and continues for twelve hours, when it is at its height; then she cannot speak, owing to the severity of pain; she lies on her right side, and keeps the fingers pressing the temple. As to the kind of pain, I got nothing but this expression:—"It is an overbearing pain." It does not throb; there is no burning sensation, but a shooting and darting; it goes off at once; her head begins to itch, and as soon as the pain is gone she is quite well again.

The seat of the pain is in the right temple and the side of the right eye; sometimes it begins in the right side, and then shifts to the left side, quite as painfully. In the case from which I take this note, the patient says the attack is preceded by a weakness in the stomach, "as if something were alive," and it goes off with the same sensation.

In another case the pain came more suddenly, and struck with more violence in frequent shocks, like those of electricity, and in this patient, too, there was an attempt to stop the suffering by pressure on the nerve.

By his experience he had discovered the anatomy of the fifth pair of nerves. Since, on the sudden recurrence of the pain, I have seen him apply his hands to his face, and press a finger firmly on all the points where the branches of this nerve make their exit from the bones of the face; pressing one finger on the infra-orbitary hole, another upon the inner canthus of the eye, a third upon the frontal nerve, and a fourth before the ear; and he would stand so, fixed in posture and trembling with exertion.

I have instances before me of the lingual division of the fifth being similarly affected. "In this lady the pain in the tongue is sometimes in the papillæ, near the root, sometimes in the tip, but always in the same side of the tongue. There is no difficulty of speaking, unless from the pain, and yet it is not a soreness, but a burning and smarting—sometimes the whole mouth is affected, even down to the throat, burning like fire."

There is a division of this class of diseases which must be distinguished—painful affections of the face, which do not come from irritation through the sympathetic system of nerves, but from direct injury to some branches of the fifth pair itself; but where the pain is referred to a different portion of the nerve, and generally to the cutaneous or more superficial branch. We have an instance of this in the severe pains which attend the shooting up of the dens sapientiæ in a narrow jaw; in the distress which attends disease of the antrum and caries of the bones of the face, through which the branches of the fifth pass to the face.

Note.—Mrs. S. For fourteen years she has experienced pain in the *eminentiæ frontales* (she places the points of her fingers there); of late the pain has been more in the root of her nose; when seized with a paroxysm, the tears flow from her right eye in a stream; when she touches the right nostril a pain strikes to her forehead; sneezing, and still more coughing, gives her great pain; laughing and crying have the same effect; bringing the teeth together brings on the pain; washing the right cheek with a soft sponge brings on the pain; any change in the temperature of the atmosphere affects her; when she goes into the open air, or when, after having been out a little, she comes into the house, a sharp pain darts up to the forehead. On examining this patient's mouth, the teeth were observed to be black, and the gums unhealthy and ulcerated: on removing two of the anterior molares of the upper jaw, matter flowed from the antrum. On her next visit, I still found the fangs of another tooth remaining buried in the gums, and the adjoining teeth black and the gums spongy. These I ordered to be removed also. After this she could press the side of the face without exciting pain, or bringing on the paroxysm, as heretofore. On her next visit, the gums appeared healthy, the pains were much relieved, but still periodical: the solution of cerussa acetata and opium continued to give her immediate relief.

Such are not the symptoms of the true *tic douloureux*, but of that case where the internal branches of the fifth pair, being irritated by disease, produce pain in their external branches.

We have another set of symptoms in the following note, which I take also from my private case book.

Mrs. F.—The burning sensation commenced on the left side of her tongue, and has gradually increased for twelve months, until it now extends over half the tongue, and mouth, and face, and head. It is a sensation as if her mouth were burnt; she has lost the sense of taste in the affected side of the tongue; she is not aware when a portion of meat is lodged betwixt her tongue and cheek. There is a numbness of the corresponding side of the face, which she says is like the pricking of a thousand needles, as when the hand or foot goes to sleep by pressure on the nerves. The end of a feather passed three inches into her left nostril gives her no sensation, and does not produce sneezing; yet she has the smell of both nostrils. On making her describe the extent of "deadness" with her finger, she runs it round the left side of the chin, and on the side and ridge of the nose. She imagines that there is a dryness of one side of her mouth, but it is not really so; there is no difference in the sides of her mouth to appearance. The pain is aggravated by speaking or by eating; and still more by coughing or sneezing. When she moves and twists her face, she says there is much stiffness to her feeling; but the action to all appearance is quite entire. She says that "the side of her face is, in a manner, dead; and yet it cannot be dead from the constant pricking pain in it."

The affected side of her face is subject to become swollen, red, and livid, and extremely hot; so that to allow her to sleep, she must then keep the lotion applied. She says she thinks she must die but for this lotion (solution of opium and cerussa acetata). It is remarked, that to relieve a painful itching at the back part of her ear and on the temple, she pinches the skin, but does not scratch it, for then great suffering is the consequence, and the pain extends all over the side of the face.

Such symptoms I conceive to come from direct disease of the fifth nerve, or from inflammation involving it.

Continuation of the preceding Case by Dr. Whiting.

" Mrs. F. called on me August 2d, 1827, for advice for a disease of which she gave the following history:—

" Twelve months previously she first felt an unusual sensation on the left side of the tip of her tongue as if it were burnt; this feeling soon extended over the left half of the organ, and afterwards over the left side of the palate, gums, and face; it was accompanied by an almost total loss of the sense of touch in the parts affected. The uneasiness had been constant from its commencement, increased however by the motions of the face, and by the contact of the hand or any solid body.

" At the period when I first saw her, the boundaries of the disease were, the ridge of the nose, the raphe of the upper and lower lip, the lines which mark the division of the right and left sides of the palate and tongue, the margin of the left lower eye-lid, the anterior edge of the meatus auditorius externus, and the horizontal ramus of the lower jaw. In none of the other parts of the face was there any evidence of disease. The morbid condition of the parts affected were, as has been described; both taste and feeling were lost from the left side of the tongue, so that she was obliged to chew on the right side only, and if the food lodged at any time between the teeth and cheek in the left side of the mouth, she was obliged to remove it with the finger. The motions however of every part of the face were properly performed, the features not at all distorted, the tongue protruded in a straight line, the temporal and masseter muscles appeared to act powerfully on both sides; she had no difficulty in utterance, except occasionally, when much excited; her general health seemed good, her appetite was strong, her bowels were confined, and her tongue rather white. Since the age of twenty-one a violent headache had frequently distressed her, which she described as going off by the face; it was accompanied with sickness and vomiting of bile: this headache had continued to return at intervals since the commencement of her present ailment.

"On October 8th, 1827, I find I reported that the symptoms had gradually increased in severity, and the disease extended somewhat beyond its former boundaries.

"September, 1828.—From the last date to this she had been nearly lost sight of by me; she had been for some time under the care of Mr. Charles Bell. On visiting her at this time, I found that she still had a distressing sensation on the left side of her face, &c., although altered in its character; her speech had become indistinct, her face was drawn to the right side, the masseter and temporal muscles of the left side had ceased to act, the tongue was protruded towards the left side, the hearing of the left ear had ceased; she could raise the left upper eye-lid by voluntary power, but could not keep it elevated; the effort to raise the globe of the eye was attended with headache and giddiness; there was considerable secretion of tears; she was emaciated and bed-ridden, and complained of great and constant pain at the back part of her head.

"About a month before her death her intellects became confused, her breathing difficult, her speech quite indistinct, and her deglutition impeded; she occasionally ground her teeth with violence, and her jaws were often firmly clenched, apparently by the contraction of the muscles of the right side: she seemed to die at length (in February, 1829) from difficult respiration, and want of the power of swallowing.

"*Post mortem* appearances.—The frontal bone was more than one third of an inch thick, and studded with numerous granulous eminences, causing corresponding indentations on the surface of the brain; the vascularity of the dura mater was increased, but not more adherent than usual to the bone; the substance of the cerebrum and cerebellum had more blood than it is generally found to contain after death, but was otherwise of a healthy appearance; about one ounce and a half or two ounces of serous fluid was found in the ventricles; a tumor containing fluid of the colour of urine (considerably darker than that taken from the ventricles), about the size, and not unlike the form, of a pigeon's egg was discovered on dividing the tentorium on the left side, bounded by the petrous portion of the temporal bone, the pons verolii, and the left lobe of the cerebellum; the part next to the pons had contracted a slight adhesion to it, and had by its pressure produced considerable indentation on the left side of it; the tumor seemed on minute examination to be a growth from the inferior surface of the crus cerebelli, just behind the junction of the pons verolii; this morbid growth consisted of a bag partly membranous, and partly medullary, the interior of which was cellular, and contained a fluid which has already been described, in a manner not very unlike the vitreous humour of the eye, excepting the colour of the fluid. The first and second pair of nerves on the left side were as usual; the third was slightly displaced by the tumor; the fourth undisturbed; the fifth appeared to come from the fundus of the tumor, passed under the dura mater at its usual place; it was flattened and thin as if from pressure, and could be traced along the coat of the tumor no further than within about half an inch of its origin. The sixth pair was healthy; but the seventh, both portia dura and mollis, was completely involved and lost in the tumor from a quarter of an inch from its origin to the meatus internus; and into this foramen no nervous structure could be seen to enter, but a substance resembling the membranous portion of the tumor and apparently a process of it; both portions of this nerve however were distinct from each other at their origin, and of their usual appearance.

"JOHN WHITING, M.D.

"250, High Street, Southwark.
"March, 1829."

From whatever cause it may proceed, whether from the more exquisite sensibility of the fifth nerve, or its more remarkable connexions, certainly all nervous affections are peculiarly apt to fall with a concentrated force upon it. Thus, in injuries of other nerves, the first symptom, before the affection spreads to the other voluntary muscles, is stiffness of the jaws. In several instances of injury of the nerve in amputation, also when the nerves have become entangled in the cicatrix of the stump, the pain has struck into the face and jaws, producing a tic.

The following cases are in illustration of the paper where it is shown that the nerves of the trunk, neck, and throat are divisible into two distinct systems: the one the symmetrical system of nerves common to all creatures, for bestowing the offices of sensation and voluntary motion, whose centre, therefore, is in the sensorium; the other a class of superadded nerves, called the respiratory system. These last are nerves which can perform their principal functions independent of the brain, and consequently of volition; for although they be dependent for some of their functions on the efforts of the will, their principal actions may proceed during sleep, or when, from any other cause, there is an entire loss of sense and voluntary motion.

The nerves of this last class are more easily excited in dying animals: they, in fact, retain life the longest, since they continue to influence the actions of respiration when sensation and volition have ceased. Thus forming a class of themselves, they are excited by sympathies which do not reach to the other nerves, and are sometimes left entire in their functions, when the other class of nerves is peculiarly the seat of disturbance. The following cases will exhibit them very subject to derangement; and will, at the same time, show the necessity of disentangling them anatomically, in order to distinguish the symptoms of disease which belong to them.

The two classes of nerves of the body are similar to the two classes of the face; but the intricacy of the former will make it long before I have such an accumulation of evidence as I have thrown together in illustration of the nerves of the face. When practitioners shall have a distinct notion of the anatomy of these respiratory nerves, cases will accumulate.

No. LVII.

Affections of the Tongue.

"July 21, 1825.

"Sir,—I shall feel obliged by your answering this letter at your earliest convenience; * * * * *

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"In consequence of your important discoveries relative to the nerves, I am particularly desirous to have your opinion on the following case. The invalid is an unmarried lady, nearly seventy years of age, who has enjoyed uninterrupted good health up to the present illness. She has had occasional short attacks of gouty inflammation in both feet, and also in the knees, of very short duration. From the first of her complaining to the present moment, she has been free from headache and from pain, numbness, or debility of the limbs. The vision and hearing are natural; the appetite good; the bowels regular, and the sleep natural. In short, there is not the slightest deviation from sound health, except in the particulars I shall relate.

"Some few months ago she had some difficulty in using the tongue, and in expressing particular words. This difficulty has gradually increased, and now she cannot protrude the tongue, or even move it. She has lost her speech altogether. The tongue itself is soft and pulpy; but it retains its sense of taste and of feeling. The deglutition is impaired, and occasionally she is distressed with a sense of suffocation, in attempting to swallow food, which she is now obliged to do with great care. She cannot hack up any thing from the throat, nor draw any thing from the posterior nares by a back draught. The features of the face are quite natural, and the skin retains its feeling. The saliva occasionally flows from the mouth, &c.

"R. W. Robinson, M.D.

"Preston."

In the body of the work, the offices of the three nerves of the tongue are slightly sketched out. This case is descriptive of a paralytic affection of the ninth nerve, a cerebral and motor nerve; and therefore I gave it as my opinion that the symptoms were more alarming, as proceeding from the brain, and threatening apoplexy.

When I have cut the ninth nerve in a dog, the motion of the tongue was lost, the power of feeding himself was lost, and it was necessary to destroy him. The power of deglutition however was entire, when the morsel was put within the touch of the back part of the tongue, and the grasp of the fauces. The motion of the tongue to turn the morsel in the mouth was lost, and there was inability to place it in the fauces, but no other defect resulted. This seems to be exactly the condition of this lady. That she can swallow, is evident from her surviving the attack, which circumstance declares the glosso-pharyngeal nerve in activity; and we are told, that she had the taste and the natural feeling of the tongue, that is, the function of the fifth nerve was entire.

I recommended in this case nauseating medicines, leeches under the mastoid processes, and a seton across the neck near the occiput, and any local appearance or gout to be encouraged.

I attended at the same time a young lady who could not swallow, and a boy who entirely lost his speech: I had the latter under my control, and can vouch for the accuracy of the detail. Suspicions often arise, that a trick is played off when these curious nervous attacks are witnessed. The anatomy of the nerves, and the study of their functions, should enable the physician to examine symptoms with accuracy, to distinguish the natural train of connexions which cannot be imitated, and thus to banish suspicion.

No. LVIII.

Case of Frederick Hill, æt. 10. *Loss of Speech.*

" Middlesex Hospital.

" This boy cannot speak, and therefore is accompanied by his mother. She says that from childhood he has been subject to a pain in his ear. About twelve months ago, he was seized with an obstinate pain in his left ear, which gave him no rest, night or day. The pain extended to his head and face, and appeared sometimes to be in the bones of the forehead, and the sockets of his eyes. It then affected his teeth, and he had toothache in every tooth in his upper jaw. After this his left eye became much affected, and he lost his sight.

" From this attack he recovered, as she describes, by large bleedings, and injections into his ear, leeches behind the ear, shaving the head, and the application of blisters. Twice he heard something crack within his head, and these sensations have been followed by the discharge of matter from the ear, with relief. The discharge does not seem to have been trifling, for she says it was at one time constant for some hours, and the fever and pain were so great, that he became delirious, and he was restrained with great difficulty by means of a strait jacket.

" It should have been noticed, that, when at the worst, he was so irritable, that the slightest unexpected noise, even the striking of a clock, would bring on one of his fits. About five weeks ago, he began again to complain of pains in his ear, which increasing, brought on delirium before night. He was now unable to eat or move his jaws, or even to speak, such motions producing a crackling pain in his ear. The day after this he was seized with a fit, in which it required two men to hold him for about half an hour, during which time he was insensible; and when it left him, and his senses returned, he was speechless.

" On the 7th October he was admitted into the hospital. He had then a discharge from his ear, accompanied with pain in the temple, and was relieved by leeches and fomentations. About a week after his admission, he threw himself down in a violent fit of passion, as it would appear, and from this moment he was entirely deaf.

" Another striking circumstance has arisen since that time. His left arm has become useless: it hangs by his side, and he cannot raise it. He can move his fingers, but not his arm; and from the middle of the arm to a little below the elbow, it is acutely painful when touched.

" He is now brought under Mr. Bell's care, who has made a particular examination of his condition. The actions of respiration are perfect. When he smiles, there is no inequality in the action of the muscles of the face. He is reported to make noise enough in laughing. When cupped, he hollowed out, and they thought every moment he would speak, yet there was no articulate sound. The boy is acute, and understands every thing communicated to him by writing. When by this means he is asked to speak, and when the throat is grasped during the effort, there is not the slightest motion perceptible in the muscles of the tongue. Yet he can masticate and swallow with ease; he can nearly touch the point of his nose with his tongue; he can turn it down to the chin and sideways. When his surgeon's name is written, and he is asked to pronounce it, he remains fixed with his mouth open. When by signs he is told to close his lips in the manner necessary to pronounce the letters *b* and *p*, and when he is then asked to pronounce these letters, there seems an utter inability. The consent of action between the chest, larynx, and mouth, seems to be lost.

" This patient was repeatedly purged with calomel and jalap. He had leeches applied behind the ear, fomentations to the side of the head by means of steam, and blisters.

" Nov. 22.—This boy's condition is considerably improved. He tosses the arm which was affected over his head, smiling obviously in exultation. It is reported that he is now able to whistle; and as this is an action in which the muscles of the chest and lips are associated, it appears to be a contradiction to a former statement; but on witnessing this attempt, we find that he makes a faint noise by drawing in his breath, and that, in fact, he cannot whistle. He is asked if he can hear himself whistle, and he says no. Being urged to say how he knows when he is whistling, he takes the slate very readily to write, but finds a difficulty in expressing himself.

" Nov. 24.—A slight spasm observed on the lower lip.

" January 7.—About a fortnight ago, this boy, being distressed with the confinement of the hospital, made entreaties to be dismissed. He came to-day, with his mother, among the out-patients. She says he thinks it hard to be tormented when there is nothing the matter. He would do any thing to avoid blistering, and being promised that nothing should be done to him if he will make a noise and try to speak, his mother telling him to call the cat, he attempts it very readily. His efforts confirm the former statement, that he is incapable of putting the tongue and larynx into co-operation in speech. The mouth is shut, the tongue and larynx perfectly still, and he makes a noise by impelling the air against the posterior nares. It is still necessary to communicate with him by writing.

" Soho-square, July 5.—The mother brought her boy to me this morning, and gave me the following account. The terror of the boy, and his extreme violence, prevented her from following up my advice, but three mornings ago he recovered his hearing and his power of speech at the same time. She had just been observing that he could not be very ill, since he was tumbling about, and throwing his heels over his head in bed. Soon after his sister came running down stairs, saying that her brother could speak, and a quantity of matter had come from his head into his mouth. From that moment he could hear, and with a painful degree of acuteness, the boy saying that the air rushed through his head. She describes his voice, too, as at first unnatural, and as if he spoke with difficulty; a circumstance which cannot surprise us, when we recollect that it is nine months since he could speak a word. He has at present an extreme tenderness in the upper part of his head, and cannot bear to be touched there. His mother says the matter which came into his mouth was very offensive. A little matter comes from his ear. There is cotton in his ears, but it is for the purpose of dulling the sensation."

This case of Hill's is not demonstrative, for happily there was no dissection to ascertain the precise nature of the injury to the nerves; but it is illustrative. There appears to have been an abscess, originally produced by disease of the temporal bone, and affecting the nerves of the base of the brain, first affecting the fifth nerve, and then spreading its influence to the seventh and ninth. If the disease had produced its influence mechanically and by pressure, there would have been no obscurity, and one side only would have been affected; but I imagine that the inflammation had disturbed the operations of the nerves, without altogether destroying their influence, deranging, for instance, the fine associations necessary to speech, without arresting the action of the muscles of the tongue*. It is remarkable, that the bursting out of matter, probably from the Eustachian tube, had such an instantaneous and simultaneous effect in restoring both hearing and speech.

The want of the power of swallowing, and the want of power of speaking, when occasioned by remote irritation, are not more extraordinary than the sounds which are produced from the same cause.

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* See Dr. Abercrombie's cases in the Edinburgh Medical and Surgical Journal, July, 1818.

I have been consulted by a young lady of 15 years of age, who had a convulsive barking noise like a cough, excepting that the larynx was alone affected, and there was no conforming action in the pharynx, velum, and lips. She would sometimes cough naturally in the intervals of this noise, but this natural coughing did not interrupt the return of the unpleasant hard bark at the rate of ten times in a minute; it ceased when she was asleep, but the moment she was awake the family heard the noise, intolerable from repetition. It continued a month, and returned three successive winters.

I have seen an instance in a young woman, where the same cause produced a more permanent and alarming effect, a spasm in the glottis, so continued and so severe, that the attendants called upon me to perform laryngotomy.

All the subjects of these odd cases, which we do not understand, get well. This is consolatory to a patient, certainly, but not very satisfactory to ourselves. Ought it not to be a question, what nervous affections are consequent on trivial irritation? Without entering on the question, whether disordered health be followed by the imperfect and deranged action of the uterine system, or whether the latter be the primary disorder—the ovaria are the source of irritation; and the consequences are exhibited through the most susceptible system of nerves, the respiratory system. Hence the disorder of the stomach, the spasms, globus, the difficulty of deglutition, the aphonia: hence the affection of the countenance, the tears, the sobbing, and spasms of the eyes and face, and throat, and chest, and stomach.

Within the space of one month the three following instances of fracture of the vertebræ of the neck have occurred in my practice. In one instance, the bones were broken at the lower part of the neck, and the patient lived some days. In the second instance, the vertebræ of the neck were fractured in the middle of the neck, and the man lived half an hour. In the last instance, the uppermost vertebra was fractured, and the death was immediate.

No. LIX.

Cases of Fracture of the Spine.

Case I.—*Percy Ward*, 29th May.—Charles Osborne, ætat. 26.—On Saturday evening this man was putting pulleys into a window sash when the small steps on which he stood slipped from under him, and he was precipitated through the window into the area, a height of thirteen feet. He thinks he fell upon his back; but he is uncertain, as he lay for some time senseless. He lies now in bed, supine and powerless, but describes the part injured to be the spine between the scapulæ. As we desire to mention only the essential features of this case, it is better to say at once, that this was a deception, that he felt the pain of the injury at a point considerably lower than the fracture, and that on his death it was discovered that the arches and bodies of the sixth and seventh cervical vertebræ were broken.

The lower extremities are motionless and insensible. He can raise his shoulders and bend his arm, but over the motion of the hands he has no power.

Another report adds—his expression is singular; he says he can move his arm by the strength of his shoulders, which is exactly true, for by moving the shoulder he can give a certain rotary motion to the humerus, and, consequently, move the fore-arms when they are bent at the elbow. The skin of the arms, however, retains its sensibility to the point of a pin. The abdominal muscles are relaxed, and the viscera feel flaccid. He can make no effort to expel the urine; his urine is drawn off by the catheter, and his fæces pass involuntarily: there is priapism. When I induce him to attempt an effort and to strain, no change on the abdominal muscles can be felt; there is no firmness or rigidity in them. The integuments of the abdomen and of the chest, as high as the nipples, are insensible.

His breathing is frequent, and at each inspiration the chest is heaved with a short and quick movement: at each expiration the abdomen is protruded with a sudden shock and undulation. The belly, during this effort of breathing, is uniformly soft and full; when drawn in, it is by the elevation of the ribs, and when the chest falls, it is protruded.

He has been observed to yawn naturally. Query. Can he cough?

An examination has been made to-day to answer this query. When he is asked to cough, he pulls up the ribs and extends the chest, and lets them fall: he coughs, but not strongly: it is obviously by his power of raising the chest and giving elasticity to the ribs, and by the weight of the parts falling, that he is enabled to expel the breath. He cannot divide the expiration into two coughs, nor give two impulses to the air; but each time he coughs the elevation of the chest must precede it.

On spreading the hands and fingers on the side of his chest the action of the serratus muscle could be felt, and also the lower margin of the trapezius muscle was felt to become firm during the act of inspiration, as when he prepared to speak.

Being asked if he had sneezed by any chance, his answer was—“ No, sir; I cannot blow my nose.” This was not that he could not raise his hand to his head: he was conscious of wanting the power of forcibly expelling the air. Mr. B., taking a handkerchief from a nurse, and holding the patient’s nose as a woman does a child’s, the patient could not blow the nose; he could not give that sudden impulse of expiration which is necessary.

In one of the reports of this case it was stated that the patient was disturbed by horrible dreams. This is very likely, from the respiration being in part obstructed; but it was omitted to verify that observation during the patient’s life.

It is remarkable in this case, that on feeling his stomach, he of his own accord, marks the difference of sensibility, internal and external. He says he feels internally, but he does not feel on his skin. He feels me when I press the stomach, and has complained of the griping from his medicines.

This man died in the night of the seventh day from the accident. The night nurse gave no particular description of the manner of his death, further than that he seemed desirous to speak and could not: he made attempts to articulate, but was unable.

No. LX.

Case II.—James Saunders, ætat. 45, June 30.—This man fell only four feet, but he fell backwards, and struck his neck against an iron railing. The transverse processes of his fifth and sixth cervical vertebræ were found to be fractured; and there was diastasis of the articulations between these vertebræ. The body of the sixth vertebra was fractured. The spinous processes, also, of the fourth and fifth vertebræ were found fractured at their bases.

The house surgeon reports of this man, that when he was brought into the hospital he was perfectly sensible; that his face indicated great alarm and anxiety. Every time he drew his breath it was attended with an effort to raise the shoulders, and a contraction of the muscles of the throat: every time he breathed, his head appeared to sink beneath his shoulders. On putting his hand on the pit of his stomach no motion of the viscera of the abdomen could be perceived. He had no feeling even in the upper part of his chest: he had feeling on his face and neck, and indistinctly near the collar bone. He had a motion of his hands, a sort of rolling motion, which may have proceeded from the shoulders. When he spoke it was in a tremulous voice, like a man frightened: his voice was weak, but he did not speak in a whisper: the sound of his voice was more like sighing than common breathing. The pulse was felt at his wrist. In ten minutes after he was brought in, half an hour from the time of the accident, he died.

No. LXI.

Case III.—On the following day a man was brought into the hospital dead. He had fallen fifty feet, and had lighted on the ground upon both his shoulders. By the accounts of the men who carried him to the hospital, he appears to have been instantaneously killed. The dissection sufficiently proved that he was killed suddenly. For besides extensive fracture and injury to the lower part of the spine, the atlas and dentata were found fractured. The tooth-like process of the vertebra dentata was broken through just at its base. It was separated completely, and was found embraced by the transverse ligament in its natural situation upon the atlas. The arch of the atlas was partially fractured on each side, and a portion of its body, where the process of the dentata rolls upon it, was also fractured and detached.

By this fracture the medulla oblongata was injured, and the breathing instantly interrupted.

No. LXII.

A young man was brought into the Middlesex Hospital, who had fallen upon his head. He soon recovered, and lay for some time in the hospital without exhibiting a symptom to raise alarm. He had given thanks to the assembled governors of the hospital, and had returned into the ward for his bundle, when, on turning round to bid adieu to the other patients, he fell, and in an instant expired. Upon examining his head, it was found that the margins of the occipital hole had been broken: no doubt it had happened that, in turning his head, the pieces were displaced, and had closed and crushed the medulla oblongata, as it passes from the skull.

No. LXIII.

A man was trundling a wheelbarrow in Goodge Street, which is immediately adjoining the Middlesex Hospital: in going from the carriage-way to the flag-stones he met the impediment of the curb-stone. He made several efforts to overcome it, and at length drawing back the wheelbarrow he made a push, and succeeded; but the wheel running forward, he fell, and remained motionless. He was taken into the hospital, but he was found to be quite dead. The tooth-like process of the second vertebra of the neck had burst from the transverse ligament of the first. The impulse given to the head had done this violence, and had at the same time carried forward the spinal marrow against the process, and on which it was crushed.

These two last cases occurred before my time, but I have had two instances of sudden death from dislocation of the atlas from the second vertebra of the neck. In short, the fact is perfectly well ascertained.

No. LXIV.

A patient, who had a deep ulcer in the back part of the throat, was seized with symptoms like those of apoplexy. These symptoms continued for two hours. At this time the patient's head fell suddenly forward, and he instantly expired. On dissection, it was found that the ulcer had destroyed the transverse ligament, which holds the process of the dentata in its place. In consequence of the failure of this support, the process was thrown back, so as to compress the spinal marrow. The parts are preserved in my collection.

We have here another proof that when the medulla oblongata is crushed, the death is instantaneous; and that the respiratory nerves, being those of expression, no contortion or mark of agony accompanies this sudden death. But there is another important feature here: the apoplectic symptoms preceded the crushing of the spinal marrow. If this disease had occurred lower in the spine, it would not have been different from the common case of paralysis of the lower extremities from disease of the vertebræ, where the communication of inflammation to the spinal marrow or its theca, and not the mechanical pressure of the bones, occasions the defect of sensibility and motion.

No. LXV.

A man was brought into the hospital, having had a severe injury of the head. Two attendants were doing their duty to him; one was letting blood in the arm, whilst the other was shaving his head: the blood suddenly stopped, and the operator looking up, saw that the patient had ceased to breathe, and was without motion or expression of any kind. On dissection, it was found that the fracture had gone through the foramen magnum of the occipital bone, leaving a loose portion. By merely turning the head in shaving, the loose portion of the bone had been turned upon the spinal marrow, and crushed it.

I have seen various examples of fractured spine, but none better calculated to illustrate the function of the nerves of respiration than those described above. But the following case of diseased vertebræ is very instructive.

No. LXVI.

Case of Palmer.—Effects of Disease of the Spine.

" October 4, 1825.—James Palmer, æt. 16., was admitted into the hospital, under the notion that he was suffering from a blow upon the head. But, on inquiry, it is found that he received no violent injury, and that a man in good humour had struck him with his open hand on the top of the head. It is not possible that this could have hurt him, unless the disease we are presently to describe had made some progress.

" The surgeon, on examining this patient and hearing his story, directed his attention to the spine, and on feeling the nape of his neck, he desired that a minute account of his history should be made out.

" The patient states, that about three months ago he caught a violent cold, attended with sore throat, and stiffness and swelling round the neck. When the general swelling subsided, there came on a swelling at the back of his neck, which continued to increase until he felt a numbness in parts of his arm and fingers, and likewise in the leg. He at length lost the use of the right arm and leg, and was brought here in the condition to be described.

" There is a swelling round the spine on the back of the neck. It is a thickening of the ligaments and cellular membrane around the bones; the tumefaction is greatest on the right side of the neck. He complains of no pain, and to a certain degree he can bend his neck. He requires assistance to move either the arm or leg of the right side. The left side is less affected. On the 8th of October an issue was made on each side of the cervical spines. They were made with a cut of the scalpel, and bled freely. Next visit he was sensibly better; he could move his arm and leg. But on the following visit he was in the same state as when admitted.

" It being supposed that so immediate and so short an influence could only be attributed to the loss of blood, eight leeches were applied round the issues, and ordered to be repeated.

" 14th. Within the last few days he is worse. He complains of more numbness, and can neither move leg nor arm. He has pain down the right side of his neck. When he attempts to move the head, he has great pain, and the pain is increased when the head is permitted to fall forwards. A stuffed collar is ordered to be applied so as to support the head in every position of the body, and to give rest to the inflamed vertebræ. The issues to be frequently touched, and kept active, and leeches to be applied round the issues. His bowels are attended to.

" 18th.—This boy breathes better, feels better, and turns his left hand more freely: and, as the pulse admits of it, the leeches are to be continued.

" 19th.—To-day he is certainly not better. He lies a little twisted; his breathing is more laborious. He complains of the difficulty of breathing, and being asked to say in what respect, he says it requires more effort in speaking, and he cannot continue it without increasing difficulty.

" 20th.—He is worse to-day. Upon being asked for his hand, which he supposed was lying across his breast, he was much surprised to find it lay by his side.

" 25th.—His breathing is difficult; he complains of a sense of weight upon his chest; his voice is much more feeble. He cannot call out; and when he endeavours to do so, it is very feebly; and he says it appears as though his voice came from his neck. On examining the muscles by which he breathes, we readily discover the sterno-cleido mastoideus in strong action. The abdominal muscles are totally inactive and loose.

" 7th January.—From the wasting of the abdominal muscles the motion of the intestines can be seen through them, and from their state of relaxation the hand can be pressed very deep under the scrobiculus cordis; in doing which he is sensible of pressure against the stomach, although insensible on the integuments of the belly. When he attempts to cough, he raises his chest, but can give no impulse in discharging the air; he expires by the falling of the chest merely.

" Among other circumstances it deserves notice, that, when asleep, his thighs are involuntarily drawn up; and of late his limbs are thus continually drawn up, and he has no power of pushing them down. About a week ago he was attacked with pain in his head, and had the sensation of water trickling down into his ears; since which he has been deaf.

"Sept. 1.—It is now some months since any note has been taken of this case, and the improvement is remarkable. The motion of the right arm first returned, and then of the left. He afterwards began to move his right leg, and then the left. At last he managed to get out of bed, and crawl about the ward: he is now, with the aid of crutches, able to walk to the water-closet. He complains of pain in his jaw on the left side.

"In all this time, the treatment has consisted of attending to his torpid bowels, that no distressing accumulation might take place; and care has been taken to keep the issues in his neck active, and to preserve the vertebræ from being moved.

"Mr. Bell, who is curious to observe the effect on his voice, makes him call the nurse, which he does now of himself whenever he sees his surgeon approaching on the visit. This is to show how much he improves. When this experiment was first made, he raised his sternum by evident exertion, and let it suddenly go down in pronouncing the word, nurse. Of late the power of enforcing the voice by the action of the muscles of expiration has been resumed.

"28th.—He now walks about the ward, and has the use of both legs and arms; but the right arm is the weakest.

"He knows when the fingers of the right hand are touched; but if you close them while his head is turned away, he is not aware of their position, unless the points of the fingers touch the palm; so that if you extend the fingers, he says they are bent. His speech is much improved, and all the functions of the body restored."—"Was made an out-patient."

This case of Palmer is very interesting, and abundantly confirms the result of the cases of fracture of the spine. By the progress of inflammation beginning in the vertebræ, and propagated to the spinal marrow, we see the function of the spinal marrow slowly debilitated, and at length the symptoms coming to resemble those produced by the crushing of the spinal marrow by the broken vertebræ. But here we can observe the gradual failure of strength, and the consequence of inactivity, in the wasting of the muscles. The most remarkable effect of this was the possibility of seeing the intestines moving, and the relaxed abdominal muscles partially rising and falling according to the distention and contraction of the intestinal canal. This state of the abdomen permitted us to examine the stomach, and to ascertain that its sensibility was entire; and it is fair to conclude, that this was through the influence of the par vagum. The branches of this nerve to the stomach, like its sub-divisions to the larynx and pharynx, are in possession of two functions; the peculiar sensibility of the part is bestowed, and the arrangement of the muscles is formed, through its influence. It must be remembered, however, that this double office proceeds in all probability from its receiving additional branches from the spinal nerves just as it is emerging from the base of the skull.

As the symmetrical system of nerves to the trunk became impaired, the muscles supplied with the accessory respiratory nerves became more excited, and rose higher into action. At the same time, the voice became feeble. This is easily understood, for the strength of the voice results from the impetus with which the breath is expelled. In this case, the active muscular power of expelling the breath was lost, with the other voluntary powers of the trunk and extremities; and by this we see the importance to life of these accessory nerves of respiration, for continuing to possess power over the diaphragm, serratus magnus anticus, trapezius, and sterno-cleido mastoideus, they supplied a force of inspiration sufficient to preserve life, until amendment took place in the spinal marrow, and common spinal nerves. No one, I apprehend, will be bold enough to affirm, that if the muscles of the neck and trunk had been as entirely deprived of action as the abdominal muscles were in this case, the patient could have survived by the mere action of the diaphragm.

If the diaphragm were to act alone, it would pull down the margins of the chest; and in as far as the diaphragm tended, by its action and by its descent, to produce a vacuum, the ribs, by their yielding to the action of the diaphragm, and their descent, would render the muscular effort nugatory; for inasmuch as the cavities of the thorax would be enlarged in their long diameter by the descent of the diaphragm, so much would they be diminished transversely by the descent of the ribs and sternum. But when the serratus and mastoideus raise the thorax at the same moment with the contraction of the diaphragm, circumstances are materially altered. The ribs and sternum are raised against their elasticity, and consequently opposed to that state to which they would recoil even in death. The expansion of the margin of the chest increases the effect of the muscular effort of the diaphragm, the arch of that septum is contracted and bears down, and the abdominal viscera are lifted up, which, on the cessation of effort, recoil by gravitation into their position; and thus the elasticity of the ribs, and the weight of the parts opposing the muscles of inspiration, preserve the life when the muscular power of expulsion is gone. There would in like manner be a defect in *expiration;* for if the diaphragm acted alone, the margins of the ribs would be drawn down, and when it relaxed, they would fly up by their elasticity and expand the chest: thus interfering with expiration.

That accomplished physician, Dr. Cooke, conversant as he is with all authorities, touches on that of Boerhaave. " Boerhaave notices the fact, (of the organs of respiration and the action of the heart being entire in paraplegia,) and observes, in explanation of it, that the moving powers of the viscera can scarcely be said to arise from the nerves of the spinal marrow, but from the fifth, sixth, and eighth pair, and the recurrent nerves of Galen." I hope it is not necessary to prove that these nerves are altogether insufficient for the purpose. This admission of the opinion of Boerhaave by an author whose work immediately preceded the publication of my papers, and by one so fully informed by study and experience, shows how long this department of our science has been stationary.

No. LXVII.

The case of Mrs. G. has recurred to me. That lady's condition was very interesting, and might have been used as illustrative of my views of the nerves.

She was quite helpless, sat in a reclining posture, supported with pillows, and surrounded by officious relations and maids, for she had her eyes and her senses. She had totally lost the use of all the voluntary muscles; her legs and arms lay motionless; her tongue refused utterance;

she attempted to speak with her mouth open, and, in a manner, from her breast; her eyes moved, and were expressive; her face had expression, she smiled pleasantly, and could frown.

Her great suffering was an indefinable uneasiness and consequent fretfulness, which occasioned the attendants great trouble in lifting her, and turning her continually. That she could swallow, her long suffering sufficiently proved. She breathed easily.

The remarkable circumstance here, was the total want of all motion of the bodily frame, unless in the actions of respiration, which were perfectly free.

In the former edition I mentioned this case; but the above note, which is somewhat more particular, I have since found among my papers.

No. LXVIII.

Lynn, March 6th, 1829.

"Dear Sir,—The case to which you allude I recollect transcribing partially from my notes, and forwarding to you, in April 1827, as follows:—'The power of moving the limbs entirely lost; can utter only indistinct guttural noises; senses of sight, smell, taste, hearing, and feeling, perfect; breathing regular and easy; eyes bright; countenance natural in expression; deglutition defective; the effort often exciting distressing paroxysms of cough and choking; contents of bladder and rectum regularly evacuated; though latterly, at times, with some difficulty.'

"I was called in at an advanced period of the disease, and could not gain a very clear account of the previous progress; but, I have much pleasure in extracting from my note-book all the particulars I could collect.

"Two years preceding the above report, the lady, upwards of fifty years of age, of a delicate, nervous temperament, whose health previously had been tolerably steady, sustained a severe fall, striking sharply the lower part of the spine, and back of the head and neck; the immediate symptoms produced were, slight stunning; nausea and faintness, which soon passed off. Some little time after this accident, she complained occasionally, of headache and dizziness; and in the course of a few weeks it was observed, that she walked hesitatingly, dragging slightly the left leg, which she noticed as feeling weak; to these symptoms succeeded after awhile, hesitation of speech, and an unusual thick guttural pronunciation, and a consciousness of some difficulty of moving the tongue whilst eating or speaking. The left arm now became weakened. In this state she continued for a time, when after a second fall, by which the back of the head was forcibly struck against the edge of an open door, the weakness of the left side rapidly assumed a more decided paralytic character, and appropriate treatment was instituted, but with little effect; as the right leg began to feel uneasy, from twitching of the muscles, and the hand of that side became weak, and affected with numbness, alternating with pricking and tingling in the fingers; and ere long the state of this arm became similar in all respects to the left: the speech became more and more indistinct; and the difficulty of swallowing gradually increased. Contrivances to enable her to communicate with her attendants were now resorted to; and as long as she was able to direct a small stick to letters printed on pasteboard, she could make those around sensible of her wants and wishes: but for some weeks before her death, she lost all power of moving the hands and arms. My report to you conveys the state in which she continued to the last; excepting that the muscles of the neck lost their power, and the saliva could not be retained in the mouth. It appeared also, from the flaccid state of the abdominal muscles, that the expulsion of the fæces and urine was latterly chiefly effected by the action of the diaphragm.

"At no time, during my attendance, was there any particular acceleration of pulse, or other indication of fever; and never the slightest wandering, or loss of memory. The paralytic symptoms marched on unimpeded by any treatment.

"I could never discover any loss of sensibility; it was natural in degree, and uniform over the whole surface of the body: the slightest pressure of the legs, toes, fingers, or arms, was immediately perceived. During the act of yawning, or sneezing, no motion of the arms was observed. The muscles of the neck and trunk were the last to give way; she could nod, slightly turn the head, and bring the trunk forward, to within a few weeks of her death, after all power in the extremities had ceased. She frequently coughed, and occasionally sneezed; and had the power almost to the last, of producing sounds by expelling the air rapidly from the lungs: but it could not be called distinct shouting.

" I subjoin the dissection of this case, which took place 36 hours after death.

" The skullcap being removed, the dura mater appeared of an unusually dull blueish cast; and cutting through it, a quantity of limpid serum, to the extent of six ounces, escaped. The pia mater was of a slight milky colour, and many patches of gelatinous matter were effused between it and the arachnoid. I considered the membranes generally as thickened, but the vascularity not unnatural. The substance of the brain might be said to be somewhat softer than usual, but the season was excessively hot, which may account for it. Throughout the mass, nothing was observed that could be construed into alteration of structure. In the ventricles, rather more fluid than common was found: the nerves at the base, and the medulla oblongata, were carefully examined, and appeared free from disease; but the membranes towards the foramen magnum, and the sheath of the cord, as far down as the sixth cervival vertebra, were thickened, and highly vascular; and this was particularly remarkable at the anterior part of the sheath of the spinal canal. I removed the fourth, fifth, and sixth arches, of the vertebræ of the neck, in consequence of their spines projecting, and found the anterior half of the cord, in this space, in a semifluid state, approaching nearly to the consistence of cream, whilst the posterior portion possessed its usual firmness.

" I have been led into this lengthy detail, in consequence of your requesting a minute description of the case; and should any part of it appear obscure, I am ready to answer such questions as you may deem necessary to put to me.

" The fall appeared to bring on low inflammation; effusion was the consequence, and the paralysis, the effect of the pressure from the fluid.

" I am, dear Sir,
" With the greatest respect,
" Very much your obedient Servant,
" Thomas Ingle."

I give the following instance to show how independent the act of breathing is of the state of the brain. It is written by an old pupil, on whose accuracy I have a perfect reliance, and whom I expect to see one day in the first rank of his profession.

No. LXIX.

A Child breathes after the Brain has been destroyed.

" After the membranes had given way, and the liquor amnii had escaped, the midwife on examining found another membranous bag presenting, which she naturally supposed belonged to a second child, and therefore did not interfere. During the passage of this bag under the os-pubis it suddenly burst, and the whole of the brain escaped from the opening very much smashed, and hanging together only by its membranes. The child breathed with perfect freedom and cried strongly, rolling its eyes about in a wild, staring manner. It moved its lower extremities freely, and that not from spasm, but obviously in obedience to external impressions. There was no motion whatever of the upper extremities.

" In this state it remained for about three hours, when all motion in the extremities ceased; the eyes became fixed, and the breathing gradually slower till it ceased altogether, just seven hours after the birth of the child. During this time neither urine nor meconium passed, nor had there been any hæmorrhage from the vessels of the brain.

" On examination, the occipital bone and the posterior part of several of the cervical vertebræ were found wanting, and their place had been occupied by fluid, surrounded by a membranous bag; an instance of spina bifida of the neck. The spinal marrow was perfect.

" A somewhat similar case occurred to me about three years ago, when I had occasion from peculiar circumstances to remove the brain of a child through the anterior fontanelle. In that instance, about ten minutes elapsed before its birth, yet it drew a deep inspiration, and would have cried had it not been prevented; and the motions of the lower extremities continued about half an hour, although the whole of the brain had been removed, and a blunt instrument repeatedly thrust down the foramen magnum.

" I am, dear Sir, yours very truly,

" Berners Street." " J. SWEATMAN.

Even the more common case of *hemiplegia*, or the defect of motion in one half of the body longitudinally, affords us the opportunity of distinguishing the act of respiration from voluntary action. For although the patient cannot, by a direct effort of the will, move the muscles of the side of the neck, or of the shoulder, yet when he draws breath, coughs, sneezes, or yawns, these muscles are put in action*.

I have observed, that when the spinal marrow is cut through by a fracture of the spine, and the accessory nerves of respiration alone remain to animate the chest, the patient can yawn, but he cannot cough. Yawning is an act of the respiratory system, in which the muscles of inspiration are slowly brought into action.

The following communication from Dr. Abercrombie will throw additional light on this subject; and the intelligent reader need not be informed, how successfully this gentlemen has cultivated the pathology of the brain.

The note was addressed to the late Mr. Shaw.

No. LXX.

" I think the following case will be interesting to you and Mr. Bell. I had some time ago under my care, a man affected with hemiplegia of the left side; the palsy complete, without the least attempt at motion, except under the following circumstances: he was very much affected with yawning, and every time he yawned the paralytic arm was raised up, with a firm steady motion, until it was at right angles with his body, (as he lay in bed on his back,) the forearm a little bent inwards, so that his hand was above his forehead at its greatest elevation. The arm was raised steadily during the inspiration, and when the expiration began, seemed to drop down by its own weight with considerable force. He continued liable to the affection for a considerable time, and it ceased gradually as he began to recover the natural motion of the limb.

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* The most ingenious men, as Boerhaave and Van Swieten, will, with all their knowledge and erudition, be defective in their account of such cases, from attending to the muscles without considering the sources of the muscular power. See the valuable works of Dr. Cooke, in the part Palsy, p. 36.

"Very sincerely yours,
"John Abercrombie.

"Edinburgh, 26th March."

No. LXXI.

Spasmodic Twitching of the Respiratory Muscles of one Side.

The unpleasant spasmodic actions of the muscles of the face, noticed in the text, are very common. This, in the slighter degree, is continued, in some instances, upon the side of the neck and chest, through the influence of the same class of nerves. The following is an excerpt from a communication on this head.

"At every interval of three minutes or thereabout, there is a *sniffing* and twitching of the nostril of one side, the eyelids of the same side are at that moment spasmodically closed, and the angle of the mouth forcibly drawn towards the angle of the jaw; the chin is tilted upwards and sideways, and there is a wriggle and retraction of the shoulder. While there is this audible sniffing and contraction of the face and shoulder, there appears to be a motion of the diaphragm, and of the muscles of the side of the chest; and this I judge of in part from the motion produced, but principally from the drawing of the breath, which causes a sound at the moment that the spasm of the face takes place."

This is the description of a very frequent disorder. It interferes with no necessary action of the parts, for it ceases while the patient is actively engaged, as if the voluntary effort could stop the tendency to spasm in the respiratory system; it is, however, increased by agitation and speaking.

These motions are sometimes very ludicrous. In conversing with a patient with nervous affection I could have believed him a cobbler; his forearm being half bent, and his hand closed with the thumb projecting: whenever he became animated in discourse he gave a jerk across his stomach, which I cannot describe more shortly than by saying it was like that of driving an awl through a piece of leather. It was obviously connected with his speech, and I must therefore imagine was an affection of the serratus anticus magnus.

No. LXXII.

Note.—The gentleman who came in to me this morning, has the slighter degree of spasmodic affection of the face. There is a tremulous motion of the eyelids of one side, which is sometimes accompanied with a drawing of the corner of the mouth. It begins with a twinkling of the fibres of the orbicularis muscle, and is followed with a sardonic grin, owing to a slight contraction of the muscles inserted into the angle of the mouth; with an agitation of the cheek like the effect of emotion, as if he were about to cry. It comes on when he is anxious, or when people look steadily at him. This nervous affection seems to have been produced by great depletion; it occurred about seven years ago, after an inflammation of the chest, for which he was bled on five successive days. I must recollect, however, that he is subject to spasmodic asthma, for which he says it is necessary to undergo bleeding and blistering. He comes to me in the expectation that I should do some operation on his face to stop this motion. This I could do effectually, but I have explained to him that a worse effect would result in the loss of power over the eye-lid.

No. LXXIII.

A Spasmodic Affection of the Respiratory Nerves and Muscles.

“ Anne Roper, in June, 1825, was admitted into the physicians' ward, having a spasmodic affection of the muscles of the face, neck, and chest, which has no perfect intermission. She ascribes her present condition to having had dysentery, followed by prolapsus ani, a short time ago, which occasioned great distress. She says she has never been well since. Her bowels, at present, are out of order, and the catamenia are irregular.

"The condition of this woman is very peculiar: in her common breathing inspiration is performed with a sudden spasmodic action: but she is also affected at intervals with more violent spasms, and her respiration is then hurried and distressing. On the commencement of a paroxysm, she bends her body slightly forwards, and thus prepares herself as it were for the attack: her nostrils are dilated widely, the angles of her mouth are dragged forcibly downwards, there is a constriction of the throat, and the shoulders and chest rise convulsively, as when a person has cold water poured upon the head; the inspirations are deep and violent, and are attended with a sniffing of the nostrils, the air being inhaled through them only, and not through the mouth. The fibres of the platysma myoides start into view, and there is a quick rising and falling of the pomum Adami; the sterno-cleido mastoideus and trapezius on both sides, act powerfully, fixing the head and elevating the shoulders.

"The spasmodic action of these muscles exists to a considerable degree constantly, yet it increases in paroxysms which last so severely for a few minutes that she is deprived of the power of speech, and seems to be almost suffocated. These paroxysms recur at irregular intervals. It was observed by the attendants, that when she was excited by walking about the ward or by replying to our questions, they returned more frequently.

"She could move her head with perfect freedom when we requested her, but still the spasmodic action continued. She also raised either shoulder, or twisted her face to one side, when she was desired. This woman continued under the care of the physician for about a month, and was discharged cured."

The case was successfully treated by Dr. Southey.

No. LXXIV.

Case of disordered Action of the Muscles of the Neck.

November 18, 1826.

A gentleman came this morning to consult me on account of a painful and spasmodic condition of the muscles of the side of his neck.

About twelve months ago his mind was exceedingly harassed, and to this he attributes his present symptoms. His countenance betrays want of general health, his stomach and bowels have required attention. He has been consulting the usual fashionable round of medical gentlemen. He has taken five grains of the blue pill at night for some time. His complaint is a wry neck. The position of his head is not constantly awry. He can turn it in all directions, but at times (and I think while conversing with me) his head is gradually and by little and little turned round, until his right ear comes near to the sternum, and the chin is pitched upwards, and to the left side. The sterno-mastoideus is of Herculean strength, and when you grasp it in its state of action, it is as large as the biceps of a powerful man.

The contractions extend to the muscles of the neck and shoulder, corresponding with the distribution of the *nervus accessorius*, or superior respiratory. I made him strip, but could not observe that the serratus magnus was at all affected*.

In this case we have an affection of a respiratory nerve, distinct from the common voluntary nerve, and bearing an analogy with the more common instances, because more observable ones, of the affection of the *portio dura* in the face.

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* His pain was in the mastoid process behind the ear. But this was an indirect effect of the complaint, and proceeded from the violent action of the muscle.

No. LXXV.

Spasmodic Action of the Sterno-cleido Mastoideus, producing a continual Motion of the Head.

Anne Turrell, aged 19. Northumberland ward.—This young woman received an injury of the chest. The blow was so severe as to break the bone of her stays, and was followed by spitting of blood. The treatment necessary for this complaint brought her very low. She describes herself at this time as oppressed with a heaviness and numbness of one side of her head and face, and having the sensation of cold water poured down her neck. This continued until the commencement of this singular motion of the head, which is the most remarkable symptom in her complaint. Conceiving this condition to be an effect of weakness, she left the hospital into which she was first received. From that time, however, until she came into the Middlesex Hospital, the motion of the head has continued.

" There is a perpetual rolling of her head night and day. It was first noticed whilst she was in bed, by a patient who lay near her. The head turns twenty-two times in the minute. The action producing this rolling motion is in the sterno-cleido mastoideus, trapezius, and splenius muscles, first of the one side and then of the other, so as to move the head on the tooth of the dentata as regularly as if it were swung round by a pendulum; and this continues night and day. Her breathing appears to be perfectly easy; there is deafness in the right ear, and a degree of lassitude in the right side."

This young woman continued an object of interest for some months, her complaint being principally referred to her stomach. She was at length seized with an attack of hæmorrhage from the lungs. She was repeatedly bled, and consequently reduced low, and became hysterical.

But what was remarkable, was the amendment of this motion in the head under the general debility. The motions became quicker, and the rotation to a less extent, like the diminished oscillation of the pendulum, from being shortened; and when in bed asleep, the motion ceased. Another attack of hæmoptysis succeeded; but, notwithstanding, the affection of the muscles of her neck diminished. She was made an out-patient; and in a few days after I saw her visiting her old friends in the hospital, entirely free of the unnatural motion of the head which had so long distressed her, and in high spirits.

It has been observed, that in this case the spasmodic motion reached the muscles on the side of her neck, and that there was a weakness of one side. I am not, therefore, authorized to affirm, that the complaint was seated in the accessory nerve; nevertheless, it is my belief that it was so, and that it is the susceptibility of this nerve which makes the sterno-cleido mastoideus muscle so frequently the seat of those deranged actions.

No. LXXVI.

Spasmodic Contortion of the Head and Neck.

Mary Preston, aged 19.—This young woman was brought from the physicians' ward into mine, that I might have more frequent opportunities of studying her case.

" The sterno-cleido mastoideus, and the trapezius of the left side, are subject to almost continual actions, which twist her down to that side; the ear is brought near to the shoulder, the head turned round, and the chin pitched up, whilst the shoulder is elevated, and the body bent. These violent actions are attended with considerable pain.

" The actions of the muscles are not constant nor regular. The violent contractions come at intervals. The sterno-cleido mastoideus first comes into action, drawing the head forwards and downwards; then comes the trapezius, twisting the upper part of the trunk, and carrying the shoulder to the ear.

" This has continued with longer or shorter intervals, about eighteen months. It began by slight degrees. She first perceived that she had a drawing of the head towards the shoulder, with little pain, and slight inconvenience. Previous to this attack she had been delivered, after a severe and protracted labour. She is now obliged to support her head with her hands, otherwise it is drawn completely down to the shoulder. She complains of pain in the head, which is attributed to the continual action of the two muscles."

I am often obliged to cease conversing with her, and to draw off the pupils from the ward, seeing that her anxiety increases the violence of the spasm. I ordered to this patient a soft-stuffed collar, to be put round the neck, on which I hoped the head might rest, and save her from the necessity of carrying her head, as it were, continually in her hands, which was a thing painful to witness. But no support or control by bandage could be borne.

When first brought into the surgeons' ward, she was found to have scarlatina; after this I thought I had got some indication, in her vomiting three *lumbrici*. After a course of worm medicine, she had an attack of continued fever; and it was necessary, in her debilitated state of health, to send her out of the hospital*.

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* *Obstipitas lateralis.* Musculi sterno-mastoidei dextri strictura, Boerhaave, Consult page 220. Tulpii. lib. 4. cap. 57. Boneti. Mercur. Compil. page 130.

" Syndicus Genevensis sexagenarius, vir rebus publicis diu intentus incidit in obstipitatem lateralem: caput ipsi, vellet nollet, dextrorsum vertebatur, sine inclinatione, adeoque ab oppositi lateris sterno-mastoideo musculo trahebatur fortius et ab antagonista debilius: in utro horum foret vitium roboris aucti vel imminuti, vix cognosci poterat, nec tensio alterutrius musculi id satis indicabat. Præscripta incassum multa remedia ut apud nos aquarum thermalium affusio, suaserat Boerhaave sequentia, 1°. de lapsum aquæ calidæ in nudum caput mane et vespere ad septem minutorum spatium quotidie per sex septimas cum frictionibus moderatis: post has embrochas: 2°. locum dextri musculi sterno-mastoidei mane et vespere inungendum diu unquento althææ composito: 3°. totam plagam sinistri seu antagonistæ eodem tempore fortiter confricandum pannis siccis, succini accenso fumi penetratis, ut ejus robur invalescens parum faceret equilibrio cum antagonista obtinendo.

" *Obstipitas spasmodica.* Boneti. Lorry de Melanch. p. 115. [Læsionis artificialis sanitatis exemplum ad producendam integritatem ejusdem est in descissione artificiali musculi sani ut par sit læso, et contractio cesset. Quod è chirurgis et suadetur et fit.]

" Parochus quinquaginarius, ab studio acriori, incidit in motus spasmodicos alternos et laterales capitis, quos reprimere vel suspendere vix poterat interdiu, caput in latus inclinatum

Is it too much to ascribe the affection of these muscles to their strain in the act of delivery? Nerves are over-exerted by violent actions, as much as muscles are over-strained. I have known the shoulder of a little girl fall quite down, in a temporary palsy of the muscles which support it; and in that case it was presumed to be owing to an over-strain. We are quite in the dark as to the particular nature of the disturbance in the nerve. Apparently from the same cause we see a class of muscles become suddenly paralytic, or subject to occasional twitchings, or to violent and continual actions, by which they are inordinately increased in strength.

I think the reason of the obscurity in these cases will be apparent to the reader. It is not the muscle properly which is diseased, but the nerves: and it is not all the nerves of the muscle, but only one class, which is the reason why the muscle is so strangely and spasmodically contracted, whilst it is still under the influence of the symmetrical voluntary nerves. The muscle being an engine moved by two distinct powers, and one of these only being deranged, is the reason of the difficulty in comprehending the case.

The practice advised in the foot note at the bottom of p. cxliv. is not to be thought of. The intelligent reader will perceive the difference between this affection of the accessory nerve and the disease of the sterno-cleido-mastoideus, for which an operation is advised by modern surgeons, and that without these studies the diagnosis will be difficult.

No. LXXVII.

Case of Affection of the Respiratory Nerves on the Side of the Chest.

Physicians' Ward, March, 1824.

—— æt. 50.—We have not met with a more distinct case of affection of the respiratory nerves of the side, than is now presented to us in this patient. The following is a description of his condition:

manu sustinendo, sed noctu somno urgente compescebantur. Morbus per plures menses perseverabat cum præscripserim fomenta emollientia, occipiti applicanda, nam convellebantur musculi, qui a parte colli postica ad caput tendunt: præscripsi etiam narcotica, juscula pulli, dein lac asininum, balnea domestica, cet. a quibus melius habuit."—*Sauvages.*

"If he attempt to lie upon his left side in bed, his head is lifted from the pillow by a rapid succession of contractions of the muscles upon the right side of his neck and right side of his thorax; so that, instead of lying at rest, his head and shoulders are raised from the pillow, and the upper part of his body forms a curve. These contractions are attended with pain, and this pain he cannot otherwise describe than by saying it is like a cramp. When he lies upon his right side he is more at rest, the weight of his head and shoulders counteracting the contraction of the muscles, and keeping him in some degree steady. On being asked whether these contractions disturb him during his sleep, he says he is sensible of their diminution as he is dropping asleep. When he sits up, the head is gradually drawn to the right side, and there is an obvious contraction of the right side of his neck. The sterno-cleido-mastoideus swells, and the trapezius is very distinctly in action; so that the ear is drawn to the shoulder, and the whole body becomes bent, and the head approaches to the side. In this state the pain he suffers is seated behind the mastoid process and at the acromion scapulæ, that is, at the origin and insertion of the sterno-cleido-mastoideus muscle and the insertion of the trapezius. He complains also of the pain and spasm striking from his back to the scrobiculus cordis, as if the diaphragm were affected. He also complains of a pain which is seated in what he calls his 'swallow;' that is, a spasmodic affection of the throat accompanies the affection of the external muscles, but he has no impediment in swallowing.

"When we say to him, 'What, sir, cannot you hold up your head at all?' he makes an exertion and sits upright, suppressing his breath. But when he speaks, his head begins to descend towards the right side by a succession of little movements, until he is quite bent down as before described. When we attempt to hold his head towards the left side, we see the sterno-cleido-mastoideus in violent action on the right side, and the muscles of that side are powerful so as to overcome us. When we hold the head down to the right side, he can pull against us with the muscles of the left side: he has the voluntary power of these entire, but they are not so strong as the muscles of the right side; it appears that by use the muscles of the right side have acquired great volume and strength. At first one might imagine that there was paralysis of the muscles on the left side. But we find that it is not the ordinary contraction of the muscles of the right side of which he complains, but of a violent spasmodic and painful action. That there is no paralysis is obvious from this, that he can move his head to either side, twist round his mouth either towards his left or his right ear, turn his head in any way you choose, and raise his right or his left arm equally, throwing them over his head: all these motions he can perform when the spasm is not upon him. When it does come on, then the muscles of the right side only are affected with contractions, and those of the left side are perfectly relaxed.

"Twenty months ago, he says, he was raising a crow-bar, and he felt something snap at the upper and back part of his neck (and he puts his finger to the posterior insertion of the sterno-cleido-mastoid muscle). He does not say, however, that he felt pain at that time. A month after this he began to have pain, and still he points to the same place, the back part of the mastoid process. The pain has gradually increased with the violence of the contractions; and, as we before said, the pain is like that of a cramp, and there is no pain in the intervals of spasmodic action."

Although the source of this complaint be obscure, yet it is a stage in the inquiry to ascertain that the spasmodic contractions are confined to the influence of the respiratory nerves of the trunk of one side. And indeed without the preceding account of the nervous system, the contractions here contemplated must have remained among the very great variety of nervous symptoms, which, owing to our indolence, are yet presented to us as mere accidents of nature which it is not expected we should investigate. It would appear that this man's condition has been produced by the violence of exertion. We have learned that in violent efforts to lift weights, the muscles of inspiration are brought into aid of the merely voluntary act; and I have many cases to show that violent exertion or long excitement of nerves, and continued exertion of particular classes of muscles, are followed sometimes with paralysis, and sometimes with irregular minute spasmodic contractions, which are very distressing.

No. LXXVIII.

The following case will illustrate the distinction between the respiratory and voluntary nerves.

Mr. ——, surgeon, and a West-Indian, called upon me to hold some conversation on his own case. He attributed his unhappy condition to a malignant fever, with erysipelas, during which there had been exhibited a great deal of calomel, as much as thirty grains at one dose, which cured him; but he thought it left him subject to a gastric affection, with chronic inflammation.

However that may be, this is his present condition. On falling asleep, just at the moment when volition and sensibility cease, the involuntary motions also stop, with a sensation of death, under which he awakes generally convulsed.

His medical friends have sat by him and watched him, and they have found that when sleep is overpowering him, the breathing becomes slower and weaker, the heart and pulse also fall low, and cease to beat as sleep comes on, and after a short time he awakes in tremor.

This gentleman is very naturally in much apprehension that some of these attacks may terminate existence. But he is young, and I think the attack is essentially different from the case of angina pectoris. The case presents to us a lively idea of what would result, were the involuntary nerves subjected to the same law with the nerves of sense and volition, for then sleep, by overpowering both, would be death!

No. LXXIX.

Spasmodic Action in the Sterno-cleido-mastoideus and Trapezius Muscles.

Mr. D. a farmer, 58 years of age.—The first appearance of this patient was characteristic. He walked past me to the further corner of the room, and standing there upright, and with his head as it were forced into the corner, he began to speak to me. He said his complaint commenced with a lowness of spirits, accompanied with a pain and weight at the back of the head, and down the shoulders; and this he particularly felt when riding on horseback. At this early stage his head was not pulled down, although his friends observed that it was a little awry. This was four years ago; it is about a year since he began to feel the pulling upon his head. He feels now as if a weight pulled it down; and to keep himself tolerably easy he must hold his head with both his hands. When he sits upon a chair he throws his head over the back of it, in such a manner as to make the weight of it counteract the pulling on the muscles of the neck. When he stands up and allows the muscles to have their influence, the occiput is turned to the right shoulder, and drawn down to it; and of course if you are standing before him, you see his profile with the chin to the left shoulder and pitched up. He has pain, especially in walking, across the ribs on the right side, and this is attended with a catching and shortness of breath; and he describes it by saying, it is hard work walking; and he draws his fingers along the attachments of the serratus magnus to the ribs.

If you put your hand broad upon the side of the neck whilst the head is pulled down, you feel a powerful action in the trapezius muscle. The sterno-cleido-mastoideus is also in powerful action, that is to say, the sternal portion of it; and a strong cord of the trapezius, and of this anterior portion of the mastoideus, may be felt as they act in rapid succession, rolling the head in a singular manner, at the same time that it is pulled down. He complains of a pain just under the tubercle of the occiput, and on the ligamentum nuchæ. He describes a sensation of catching on the left side of his face.

When he coughs, there is neither increase nor diminution of the spasms. Being asked as to this point, he observes, however, that on the moment of swallowing a morsel, the pulling of the neck is brought on. When fatigued, he rises and stands in his present position, with his head and left shoulder resting against the wall, his feet at some distance from the wall, and his heels off the ground; and thus his body forms an arch from the feet to the shoulder. This patient was attended by Mr. Heelis of Limehouse.

No. LXXX.

Spasmodic Action in the Sterno-cleido-mastoideus and Trapezius Muscles.

—— This gentleman is distressed with a spasmodic affection of the side of the neck. By the death of a relation he was involved in harassing family disputes, under which he is sensible his mind has suffered. Although enjoying good health, he has been subject to bilious attacks, and has had a discharge from his left ear.

When coming into the room he presents exactly the same appearance as the farmer who lately left me. He supports his head with his hand, and seeks relief as soon as possible by propping his head against the wall, or by letting it fall over the back of the chair, supporting the occiput with the hand. He complains that his face is forcibly drawn round to his shoulder. His sterno-cleido-mastoideus muscle, during this state of constraint, is as hard as a board; but when the paroxysm is at the worst, and when the mastoid process is drawn towards the sternum, he can by volition, and in a temporary manner, relax the muscle and poise the head equally; but this is for a short time only; the incontrollable action of the muscle returns and drags down the head, twisting the face to the left side, and pitching up the chin. A rigidity of the right side of the neck, attributable to the lateral portion of the trapezius, shows that that muscle partakes of the spasmodic action. There is no complaint of the side of the chest nor difficulty of breathing. The agitation of riding over the stones makes him worse. When he is lying down, and when his head is propped with pillows, it remains almost quite still. The pain in the back of the neck appears to be rather the effect of continued exertion than of any thing inflammatory. When the paroxysm is severe, the convulsion extends to the muscles of the larynx, and he makes attempts as if it were to get rid of something which was producing a huskiness in his voice. When he supports his head and is at rest, the act of drinking brings on the paroxysm.

He is at perfect rest only when he is asleep.

No. LXXXI.

Case communicated by Mr. Alexander Shaw.

" Thomas Brown, æt. 58, a shoemaker in Ayr, has suffered for nearly three years from a spasmodic affection of the muscles of the neck and shoulder. A year or more previous to his being attacked with this complaint, his health became broken, which he says was owing to his being addicted to drinking, and reduced to a state of great poverty. He first perceived a stiffness in one side of his neck; he had also a weakness in the left half of his body, but he did not lose the command over the parts thus affected. The spasms in the neck came on suddenly, and they were at the beginning very nearly of the same kind as they are now.

" During each of these spasms his head is drawn down gradually, and by successive actions, so that the left side of his face comes almost in contact with his shoulder; but there is, in addition, a rotatory motion of the head, by which the chin is turned round and tilted obliquely upwards, towards the opposite side. His head is thrown back on the nape of his neck, his mouth is drawn open, and the whole of the left side of his face is twitched with a succession of frequent convulsions; the shoulder on the same side is elevated, and the arm is thrown forwards across the body when the head is thus drawn down. These spasms are repeated ten or fifteen times in the course of a minute. At intervals during the day the same paroxysms come on with increased severity. Then the convulsions of the face and neck are of the most violent kind: his arm and shoulder are shaken backwards and forwards with a kind of shrugging motion, and with amazing rapidity, so that the whole body partakes of the tremor. While these very severe fits last, which is for about a minute each time, his breathing is performed with difficulty, and he gasps as if he were suffocating; altogether he exhibits the appearance as if he were submitting to the most extreme suffering. During the course of the day he is attacked frequently with these violent paroxysms, but he cannot assign any reason for their being brought on at one time more than another.

" On examining him when the usual spasms were taking place, the left sterno-cleido-mastoid muscle was distinctly larger and more prominent than the other; and it became hard and round when the spasms occurred. It appeared that the anterior fibres of the trapezius were likewise firmly contracted when the spasms took place, but the condition of this muscle was not so easily ascertained as that of the other.

" He has a constant pain in the left side of his neck, principally seated at the mastoid process of the temporal bone, but extending also along the course of the clavicle. He said it was long before he fell asleep at night, owing to his head shaking against the pillow. When asleep, his friends have told him, that his head lies perfectly still; and in speaking of this, he expresses the regret which he feels each morning when he awakes, being conscious that his sufferings were immediately about to begin again. He is able to walk about the town. Various remedies have at different times been tried, but without producing any perceptible benefit."

No. LXXXII.

A Case of Spasmodic Affection of the Neck.

" Francis Barney, a healthy man 27 years of age, by trade a blacksmith, was in February last seized, without a previous illness, with a spasmodic contraction of the muscles of the neck. The spasms were slight for a few weeks, but they have since been severe and frequent, though not permanent. During the contraction, the face is forcibly drawn to the left side; and it would seem, " that the clavicular portion of the sterno-cleido-mastoideus is alone affected, or at least more especially. To give some idea of the violence of the spasms I only need say, that all the power a strong man can exert is insufficient to counteract them. Although this spasmodic affection has now continued for nine months without any material alteration, the patient's general health does not appear to have suffered. He was not under my care until July, but from the gentlemen who attended him I am informed, that the treatment in the first instance consisted of general and local bleeding, free purgation, afterwards mercury, followed by antispasmodic stimulants of turpentine, &c.; irritating applications had also been applied to the antagonist muscle, with the hope of exciting a stronger action, and counteracting the spasm of its opponent. I have never thought this spasm owing to a want of power in the antagonist muscle, but have rather apprehended that it depended upon an affection of the accessory nerve, and had consequently no great expectation from medical treatment; but having witnessed decidedly good effects from strychnine in partial paralysis, I thought it deserved a trial in this intractable case; it was therefore prescribed; at the same time a large seton was inserted in the neck. The strychnine was continued for a month in full doses, producing its usual effect, but no real benefit. He afterwards became a patient in an infirmary, where he derived no advantage whatever. Some attempt has since been made to keep the head steady by mechanical means."

No. LXXXIII.

Case of Wry Neck.

"Sheffield, June 27, 1829.

"Sir,—About December, 1827, Master —— was seized during the night with a stiff neck; it excited little attention; he played with his schoolfellows as usual, some of whom playfully, but rather rudely, twisted his head in a contrary direction. When he returned home at the Christmas holidays, I was requested to see him. I found his general health very much deranged, and his sterno-cleido-mastoideus muscle on the right side rigidly contracted. Leeches and fomentations were applied to the mastoid extremity of the muscle; alterative medicines were prescribed; strict attention was paid to the bowels; and after some weeks his general health very much improved: still the muscle remained as rigid as ever. During the summer, his father took him to London, and you were consulted. I believe he was advised to go to the sea, and a steel apparatus was recommended. The sea, I understood, was of service to him; but as the apparatus did not improve his neck, and injured his back, it was, after some weeks' trial, laid aside. A vigorous system of shampooing was then adopted, together with very active exercises. His health improved; he grew taller, and stouter; and by a great effort he could stand straight: but the moment he relaxed his efforts, his chin turned towards his shoulder, his spine became curved, and he relieved himself by resting on one leg.

"All remedial measures were at length abandoned, and this last half year he was sent to school. His general health has continued good, but his sterno-cleido-mastoideus is just as it was.

"Mr. —— has requested me to correspond with you respecting his son. I presume, to learn whether, from my description, and your notes or recollection, you have any further plan to propose. Whether you would recommend any division of the muscle, or whether, before giving any further opinion respecting him, you would wish to see him. In the latter case, I believe his father would immediately take him to London.

"I am, Sir,
"Respectfully yours,
"Arnold Knight, M.D."

This young gentleman is gradually improving by shampooing and proper exercises, which put the muscle on the stretch.

No. LXXXIV.

The wry neck is a different complaint from these spasmodic affections of the mastoid muscle.

Note.—Sir —— —— has been brought to me under the idea that he had disease of the spine, but from his appearance in coming into the room, I saw that the character of the distortion was entirely different from that produced by disease or weakness of the spine. I soon discovered that his manner of holding his head was not a habit, as the family supposed, but an inevitable consequence of the state of the sternal portion of the mastoid muscle. The head is not inclined to the left shoulder as if it were equally drawn, or had fallen, from the paralysis of the muscles of the opposite side; the ear is twisted to the shoulder, the chin pitched up, and the shoulder of the affected side is higher than the other. This appearance immediately drew my attention to the sterno-cleido-mastoideus muscle, when I found that the portion of it which runs from the sternum to the mastoid process was as firm and unyielding as a cord, and checked the movements of the head.

The distortion of the neck and shoulder arose from the accommodation of the vertebræ to the state of the mastoid muscle; and from the same cause arose the inequality of the shoulders, since the rigidity and shortness of the sternal portion of the muscle was in part relieved by the elevated position of the clavicle, just as by the depression of the mastoid process.

This disease is a degeneration of the fibres of the muscle into a tendinous texture. It is relieved, however, by proper exercises and the shampooing of the muscle.

On the Nervous Circle.

[An extract taken from the Author's Lectures delivered to the College of Surgeons.]

In reviewing these facts regarding the nerves of the face and head, a question of much interest arises; for, since we have found that there are nerves provided to carry the influence of the will to the muscular system, and that there are other nerves, distinct in their nature, whose office it is to give sensation, it may be very naturally asked, can that property or influence, which is conveyed by a nerve, go backwards and forwards along the same filament, or through the same tube? or, on the other hand, does the nervous fluid (to use the hypothetical term) pass ever in the same direction, outwards from the brain in one nerve, and towards it by another? You know what has been imagined about the function of a nerve: some have conceived that it is a vibration along a minute cord; others that the nerves are fine tubes, having an æthereal fluid passing through them; or again, that there is a galvanic fluid attached to the filaments, explaining the functions of the nerves on the analogy of electricity or galvanism extending along wires.

Now I say, that whatever hypothesis you choose to adopt, the question may very naturally be agitated, can that influence, conveyed through a nerve—be it a vibration, or a fluid, or some galvanic influence—can it, I say, be propagated by the same tube or fibre backwards and forwards, in two opposite directions, at the same instant of time? I apprehend that it cannot.

When this difficulty is stated, and is fairly before us, we look to those experiments, which prove that nerves are of a different nature, with increasing interest. Thus we have seen two nerves going to the same muscle, divided; and when we touched one of these nerves at its extremity connected with the muscle, the muscle was excited; but when we touched the extremity connected with the brain, it was attended with no result. On the other hand, taking the other nerve also connected with the muscle, (the branches of which can be seen dispersing themselves to its minute fibres) and irritating it as we did the former, the muscle was quiescent—no power was propagated in that direction; but taking the other extremity of this divided nerve (that connected with the brain), and pinching it, there was pain. What, then, is the difference of these two nerves? Is it in the direction in which they convey their impression, since it is proved that they are both connected with the sensorium, and both connected with the muscles? I am inclined to say that it is so; that the distinction of their functions depends on the course of the fluid through them, or the direction by which the impression is propagated. It may then be the same sort of influence which is excited, and the difference may only be in the direction in which that influence is propagated; for, otherwise, I am quite at a loss to explain how it shall happen, that here are two nerves going into the body of a muscle, of equal size, similar in appearance, distributed in equal branches, both sinking into intimate connexion with the muscular fibre: and if you injure the one, there is not the slightest motion in the fibre of the muscle; if you injure the other, the whole muscle is convulsed. It is from this process of reasoning, and by considering these facts, that I am inclined to say there is a circle in the nervous system; that one nerve conveys its influence towards the muscle, and the other gives the knowledge of the condition of the muscle by the influence propagated from the muscle towards the sensorium. At all events, you observe that a mistake has hitherto universally prevailed in supposing that one nerve could perform two functions of opposite tendencies.

I need not carry you back to the proofs which we had in the eye, that one nerve, be it either a nerve of sense or a nerve of motion, was insufficient for the protection of that organ; but let us consider the influence of the nerves of sensation and motion in the body, and the necessity for their co-operation. I shall illustrate this subject by a case, which you will know how to appreciate, when I tell you that it is from one of the most acute and intelligent men of our profession (Dr. Ley).

No. LXXXV.

Case of Paralytic Affection, in which sensation was diminished on one side and the power of motion on the other.

"My Dear Sir,—The case about which you have more than once expressed an interest was this:

"Mrs. W. was delivered by a midwife at Kilburn. Her labour was easy, but followed by profuse hæmorrhage upon the separation of the placenta, and after its exclusion from the uterus.

"She revived from the state of exhaustion immediately consequent upon the loss of blood, but at the end of about three or four days became feverish, and complained of severe headache: for a week, however, she had no other assistance than that of the midwife.

"At the end of this time (about ten days after her delivery), the headache continuing, and being now accompanied with some degree of 'numbness on one side,' I was requested to see her.

“ I found her labouring under severe headache, not confined to, but infinitely more violent upon one side than the other, and occupying the region of the temporal and occipital bones above the mastoid process, and attended with considerable pulsation.

“ Upon one side of the body there was such defective sensibility, without, however, corresponding diminution of power in the muscles of volition, that she could hold her child in the arm of that side so long as her attention was directed to it; but if surrounding objects withdrew her from the notice of the state of her arm, the flexors gradually relaxed, and the child was in hazard of falling. The breast, too, upon that side, partook of the insensibility, although the secretion of milk was as copious as in the other. She could see the child sucking and swallowing, but she had no consciousness, from feeling, that the child was so occupied: turgescence of that breast produced no suffering, and she was unconscious of what is termed the *draught* on this side, although that sensation was strongly marked in the other breast.

“ Upon the opposite side of the body there was defective power of motion, without, however, any diminution of sensibility. The arm was incapable of supporting the child; the hand was powerless in its gripe; and the leg was moved with difficulty, and with the ordinary rotatory movement of a paralytic patient; but the power of sensation was so far from being impaired, that she constantly complained of an uncomfortable sense of heat, a painful tingling, and more than the usual degree of uneasiness from pressure, or other modes of slight mechanical violence.

“ Medicinal agents, including blood-letting, general and local; blisters; purgatives, &c. directed, first by myself, afterwards by Dr. P. M. Latham, to whose care I directed her in the Middlesex hospital, were of little avail, and she at length left the hospital, scarcely, if at all, benefited.

“ At the end of a few months she again proved pregnant. Her delivery, at the full time, was easy and unaccompanied with hæmorrhage, or other formidable occurrence, but at the expiration of about ten days she complained of numbness on both sides. Her articulation was indistinct: she became more and more insensible, and sunk completely comatose.

“ Upon examination of the body no positive disorganization of brain could be detected. The ventricles, however, contained more than usual serum; and there were found, more especially opposite to the original seat of pain, thickening, and increased vascularity of the membranes, with moderately firm adhesion in some parts; in others, an apparently gelatinous, transparent, and colourless deposit interposed between them.

"Such is the outline of a case which I have been in the habit of quoting in my lectures, as an illustration of one of the pathological conditions which I have repeatedly observed as a consequence of great and sudden loss of blood; and as a proof that it is a state of local congestion allied, if not amounting to, actual inflammation. It, however, obviously involves many other interesting points connected with those intricate subjects which you have so successfully unravelled.

"I am, dear Sir,
"Yours, very truly,
"H. Ley."

This illustrates the fact that the motion of the muscles is governed through a consciousness or perception of that motion. Indeed it can only be from a sense of the condition of the muscles of the hand and arm, for example, that you know the position they are in when there is no contact, and, therefore, no exercise of the sense of touch. The man whose arm has been amputated, has not merely the perception of pain being seated in that arm, but he has likewise a sense of its position. I have seen a young gentleman, whose limb I amputated, making the motion of his hands to catch the leg and place it over the knee, after the limb was removed, and the stump was for some time healed; so a man, who has lost his arm close to the armpit, has a perception of that arm changing its position. It is by this sense of the condition of muscular action that we are enabled to regulate the whole muscular system, and balance the body.

No. LXXXVI.

In the following excerpt from a letter of consultation, Mr. Bailey of Thetford describes an affection of the nerves of sensation as opposed to those of motion.

"Mrs. ——, aged 66 years, a lady of high respectability, consulted me in October last, in consequence of experiencing a numbness in the hands and fingers, which to her sensation felt as if some sand were interposed between them and the object touched. There was no want of power in the muscles, excepting a slight stiffness, as any substance could be firmly grasped. So impaired is the sense of touch, that it is with difficulty she can distinguish the object wanted: this is particularly the case when feeling in the pocket. With the exception of these sensations, her general health did not appear to have suffered. There is no pain complained of; the appetite natural; the digestive powers strong, and the alvine secretions perfectly correct; the pulse was regular as to strength and number of pulsations.

"In April last, I am sorry to say, the symptoms increased, and became extremely distressing; the fingers seemed more loaded than ever, and the difficulty to take from her pocket what might be wanted (from want of accurate touch,) was more evident; with this a considerable tightness about the abdomen, extending round the back and up the shoulders and chest, was experienced, as if she were corded in different parts, rendering it difficult to turn in bed or rise; these same sensations affect the thighs and legs, which appear not to belong to her. With all these symptoms no pain is complained of."

Partial Paralysis of the Muscles of the Extremities.

This is an obscure subject, but there is a circumstance which has occurred so often in examining patients thus afflicted that I must note it down. The paralysis does not extend to a part of the arm or leg, nor is it a defect, reaching so far up the limb or so far down the limb, but it is an affection of the muscles which are naturally combined in action; although these muscles lie in different parts of the extremity, and are supplied by different nerves, as they are by different arteries. For example, the muscles of the thumb may be affected, but then the wasting will not be confined to the short muscles of the ball of the thumb, but will extend to those muscles of the thumb which lie upon the fore arm, and these wasted muscles are lying in contact with others which are plump and powerful. Or sometimes all the extensor muscles will lose their power, while their opponents preserve it, producing a characteristic position of the limb. It will sometimes happen that one class of muscles having suffered, another class will come into play, and be developed by unusual exercise. I have found the action necessary for writing gone, or the motions so irregular as to make the letters be written zigzag, whilst the power of strongly moving the arm, or fencing, remained.

No. LXXXVII.

Wasting of the Muscles of the Thumb.

Smith, æt. 22, an ironmonger.—A year and a half ago he was suddenly deprived of the use of his right thumb. The right arm, and indeed the muscles of the whole body, retain their power; even the adductor muscle of the thumb has its proper action: but the abductor, flexor brevis, opponens, that is, the muscles which form the ball of the thumb, are wasted; so that you feel the bones and the strings of tendons over them. When a comparison is made between the long extensors of the thumb on both the arms, those of the right appear to be considerably wasted, and they want the rigidity which belongs to those of the left arm; yet the tendons start out when he brings these muscles into action. He has been employed in serving out the goods in an ironmonger's shop, and has never had any thing to do with the severe work of manufacturing: he has not at any time worked much with lead, or with any paints: he has had no affection of the bowels that he can recollect: he has never had any complaint to denote an affection of the brain, nor any pain in the course of the nerves.

No. LXXXVIII.

I was consulted during the last year by the parents of a young gentleman, 15 years of age, in whom this paralysis of particular muscles, and consequent wasting of them, was very distinct. In my note of the case it is stated, that two years before visiting me, he had scarlet fever, attended with sore throat and delirium, for eight or ten days. It was after this fever that his right arm was first perceived to be weak. Subsequently the left arm became weak, and this muscular debility increased without any pain or apparent disturbance of his general health.

The muscles of the thumb are not wasted, and the flexor muscles of the wrist and fingers are powerful; he can grasp his father's hand so as to make him cry out. Yet the extensors of the wrists and of the fingers are weak, so that the hand remains generally bent, and at an angle with the arm. Whilst the forearm is firm to the feeling as you grasp it, the muscles of the arm are wasted and loose, so that you can feel all the processes of the humerus, from its upper to its lower end: the deltoid muscle is also quite gone. The rotation and motion of the arm are very curiously performed by the muscles inserted into the scapula, which are firm and strong, so that the arm is thrown about by the rotation of the scapula upon the chest. The muscles which come down from the neck to the shoulder are particularly strong, and it is by them that the scapula is heaved up and a secondary kind of motion given to the arm. All the muscles which are for bracing down the scapulæ to the chest, and drawing them backwards, are wasted, and the inferior angles of both the scapulæ start out three inches from the ribs. It is astonishing with what energy he can fling his arms about, by those muscles alone which come from the neck to the shoulder: for example, he jerks on his coat, and draws it upon his back, solely by the action of the muscles of the neck; when undressed, he can swing his arms round and round; but it is by adjusting the action of raising the scapulæ with the gravitation of the upper extremity that he contrives to do this, and seems to possess a more extensive influence on the muscles of the arm than he actually does. He is tall, and is still growing fast.

On the 17th September, I was again visited by his mother, when she reported that his muscular strength had declined, particularly in the right leg, and that it required two men to place him on the seat of the carriage. His spirits are excellent; his remarks shrewd; and his education is proceeding: he has grown considerably.

These affections of particular muscles, or classes of muscles, imply a very partial disorder of the nerves. A disease of the brain, or a disease in the course of the nerve, must influence the whole limb, or that portion of it to which the nerve or nerves are distributed. But in these cases, particular subdivisions of the nerves, included in the same sheaths, or running the same course, are affected. I am inclined to attribute such partial defects to the influence of visceral irritation. In that case, it must still be the influence of the sympathetic nerve which produces it; and yet, on the other hand, it seems impossible to account for such entire loss of motion without the intermediate influence of the brain.

No. LXXXIX.

Case of partial Paralysis of the Lower Extremities.

July 23d.—The consultation this morning is connected with this subject. The patient is a young gentleman about eighteen. All the muscles of the lower extremities, the hips, and the abdomen, are debilitated and wasted. The extensor quadriceps femoris of both limbs is wasted, and yet the vasti externi have not suffered in an equal degree. A firm ball, remarkably prominent just above the knee joint, marks the place of the vastus externus, while the rectus is quite wasted and gone. He has no defect of sensibility in the lower extremities. The upper part of the body, the shoulders, and arms, are strong. There is no defect perceptible in the evacuation of the bladder or of the bowels. There is a slight curvature or projection of the lumbar part of the spine. He is weak, and subject to palpitations on going up stairs; his tongue is coated. Altogether, his state of health is very irregular. On some days his spirits are good, on others he is depressed and unable to move. Much of this, he says, depends upon excitement or amusement, and very much on the state of his digestion.

This paralytic debility of the muscles came on gradually: he was first sensible of it at a public school, about eight years ago. It began with a weakness in the thighs, which disabled him from rising; and it is now curious to observe how he will twist and jerk his body to throw himself upright from his seat. I use this expression, for it is a very different motion from that of rising from the chair.

Affection of the Voluntary Nerves.

I could give cases of various affections of the voluntary nerves, but the patients might be made uncomfortable by a report of their condition. The most common instance is an impediment in speech, when the consent of the muscles is imperfect; but this sometimes extends to all the voluntary muscles of the body. I find that some are capable of lifting a heavy weight, or walking fifteen or twenty miles, and yet they have not the proper command of their limbs: there is an insecurity and want of confidence in the motions of the body, which overtakes them upon any excitement; a paralysis of the knees which prevents the individual from putting one leg before the other, and which endangers his falling. Thus a gentleman, capable of great bodily exertion, on going to hand a lady to the dining-room, will stagger like a drunken man; and in the streets any sudden noise, or occasion of getting quickly out of the way, will cause him to fall down, and in this manner a want of confidence produces a nervous excitement which increases the evil. With confidence, the power of volition acts sufficiently; there is neither defect of speech nor irresolution in the motion of the limbs when the person is at ease, or under a flow of spirits.

Such cases are very curious in their details, as exhibiting an extraordinary degree of incapacity for the affairs of life, proceeding from slight defects. There is neither disease of mind nor of bodily organs; the corporeal frame is perfect; the nerves and muscles are capable of their functions and proper adjustments; the defect is in the imperfect exercise of the will, or in that secondary influence which the brain has over the relations established in the body.

Note.—To the last hour of these papers lying beside me, I believe that I could add new circumstances in proof of the accuracy of the general doctrines.

Dec. 26, ——, an elderly maiden lady, consulted me on account of a cancer in the breast; but of all her more formidable symptoms, none gave her so much anxiety as an insensibility of the lower lip: her attention was called to this by *feeling only one half of the cup in drinking*. On touching the left side of the nether lip, I found that she had no sensation in all that part supplied by the *mandibulo labralis* nerve. The motions of her lips were perfect.

Upon feeling deep under the angle of the jaw, I discovered a hard glandular tumour, which was attached to the upright portion of the jaw, and no doubt pressed on that branch of the fifth nerve which enters the internal foramen of the lower jaw.

Mr. Drew, of Gower-street, saw the patient with me this morning, and observed the circumstances.

In the course of the same forenoon I had the advantage of meeting Dr. Holland, to consult on the following case:—

A lady, in travelling up from the west of England, was exposed to cold. The left side of her face is swoln and very painful, attended with a ringing in the ear of the same side. She is unable to shut the left eye-lids; she cannot frown on that side; the cheek and mouth on the same side are without expression of any kind. She has a difficulty of speaking, and when she smiles the face is drawn frightfully to the right side. Fluid falls from the left side of her mouth.

On putting the point of the finger behind the angle of the jaw on the left side, the part is very tender, and a swelled gland can be distinctly felt, which no doubt presses upon, or involves, the portio dura.

The contrast of these two cases, occurring within twenty-four hours of each other, is very striking, and some years ago would have been invaluable to me. Whilst in attendance upon these cases, Mr. Summers, of Euston-square, brought a patient to consult me in apparently similar circumstances with the last; that is to say, paralytic on one side of his face, with an inability to close the eye-lids of that side. I observed that this gentleman, in detailing the circumstances, pressed his left cheek against the bone with the point of his finger. This was to draw tight the left angle of the lips, which gave him the power of speaking more distinctly, by the motion of the right side of his mouth. This case was distinguished from the others by there being no external tumour, and it was important to notice, that he had some time ago a general weakness of the muscles of the same side of the body, from which he had recovered; that his father had

had a paralytic seizure, leaving weakness on one side, and that his sister, twelve years before, had been affected in a manner similar to his own present condition; and moreover, it was observable that he had pain in the occiput, just behind the ear. These latter circumstances gave a character of more importance to this case than to the preceding, where the cause was external.

I may just add, that a patient has been sent to the hospital, who exhibits a most remarkable instance of twitching of the face, from an affection of the portio dura. The patient is made aware of the commencement of the attack by a motion behind his ear, and in fact a remarkable agitation of the occipito-frontalis muscle accompanies the twitching of the face.

EXPLANATION OF THE PLATES.

PLATE I.

A A B B C C Spinal marrow.

1 1 Branches of the fifth pair, or Trigeminus, which arise from the union of the crura cerebri and crura cerebelli in two distinct roots, on the posterior of which a ganglion is seen, like the ganglion of the spinal nerves. The branches of the fifth nerve are universally distributed to the head and face; but the anterior root goes only to the third division.

2 2 Branches of the Suboccipital Nerves, which have double origins and ganglions on the posterior roots.

3 3 The branches of the four inferior Cervical Nerves and of the first Dorsal, forming the Axillary Plexus: the origins of these nerves are similar to those of the fifth and the Suboccipital.

4 4 4 4 Branches of the dorsal nerves, which also arise in the same manner.

5 5 The lumbar nerves.

6 6 The sacral nerves.

PLATE II.

A	Cavity of the skull.
B	Medulla oblongata.
C C	Spinal marrow.
D	Tongue.
E	Larynx.

F Bronchia.

H Stomach.

I Diaphragm.

The third, sixth, and ninth nerves are not lettered, but only the following respiratory nerves.

1 1 1 Par vagum, arising by a single set of roots, and passing to the larynx, the lungs, heart, and stomach.

2 2 Superior laryngeal branch of the par vagum.

3 Recurrent or inferior laryngeal branch of the par vagum.

4 Pulmonic plexus of the par vagum.

5 Cardiac plexus of the par vagum.

6 Gastric plexus or corda ventriculi of the par vagum.

7 Fourth nerve, a nerve of this system to the eye.

8 Respiratory nerve or portio dura to the muscles of the face, arising by a single root.

9 Branches of the glosso-pharyngeal.

10 Origins of the superior external respiratory or spinal accessory nerve.

11 Branches of the last nerve to the muscles of the shoulder.

12 12 12 Internal respiratory, or the phrenic nerve to the diaphragm.

13 Inferior external respiratory to the serratus magnus.

PLATE III.

This plate represents that portion of the spinal marrow from which the nerves of the axillary plexus go off.

A A The medulla spinalis.

B B B B The sheath or theca of the spinal marrow.

C C C C C C The anterior roots of the spinal nerves, coming down from the anterior or motor column of the spinal marrow, before they join the posterior roots, and before they pass out of the sheath.

D D D D D The posterior roots of the spinal nerves. Between these distinct roots the ligamentum denticulatum intervenes. This is transparent, being a process of the tunica arachnoidea.

E E E E The ganglions formed upon the posterior roots of the spinal nerves. It is seen in this plate that after the ganglion is formed on the posterior root, the two roots coalesce and intermingle to form the nerves.

F F F F F F The axillary plexus formed by the interchange of branches.

G G The lower cervical ganglion of the sympathetic nerve.

H H H H The sympathetic nerve forming its connexion with each of the spinal nerves.

Whilst we perceive that the sympathetic system is essentially distinct in character from the other nerves, the fact is here demonstrated that its connexions are universal; we see that each twig may be considered as the root or origin of the nerve, with as much propriety as some authors describe the fifth or sixth as giving origin to the sympathetic system of nerves*.

PLATE IV.

This plate represents the medullary portions which we trace from the base of the brain:—the crura cerebri, the pons varolii, the medulla oblongata, and nerves arising from them.

He who makes himself master of this plate can have no difficulty in comprehending the whole nervous system;—he holds the key to it in his hand.

A A The CRURA CEREBRI.

B The PONS VAROLII.

C C The corpora pyramidalia; parts of the medulla oblongata.

D D The CORPORA OLIVARIA; lateral eminences of the medulla oblongata.

E The sheath left on part of the medulla spinalis.

II. The SECOND PAIR of nerves at their union.

III. The THIRD PAIR of nerves, arising from the crura cerebri.

IV. The FOURTH PAIR of nerves, arising round the crura cerebri.

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* These connexions of the sympathetic with the spinal nerves are formed where the two roots have coalesced, and the fibrils can no longer be distinguished from one another.—See *Scarpa.*

V. The FIFTH PAIR of nerves, arising in two distinct portions from the side of the pons varolii. On the right side (the left of the plate), the posterior and larger root, the sensitive nerve of the head, is seen to arise distinct; the anterior and lesser root, the motor nerve, arises separately. On the left side (the right of the plate), the muscular root of the nerve is seen to twist round the sensitive portion and join the third division.

a The muscular portion.

b The Gasserian ganglion, formed on the sensitive portion.

c The ophthalmic and superior maxillary nerves, derived from the sensitive portion of the fifth.

d The inferior maxillary nerve, in which are combined the anterior and posterior portions of the nerve.

VI. The SIXTH NERVE, the abducens.

VII. VII. The PORTIO DURA of the seventh nerve, the respiratory nerve of the face.

e e The portio mollis, or acoustic nerve.

VIII. VIII. The EIGHTH PAIR of nerves, consisting of the three respiratory nerves, viz:—

f f The glosso-pharyngeal nerve.

g g The par vagum.

h h The spinal accessory nerve, or superior respiratory nerve.

IX. IX. The NINTH NERVE, being the lingual nerve.

X. The TENTH NERVE of the head, according to the system of Willis; properly the first of the spinal nerves, having, like these, two roots, one anterior for motion, and another posterior for sensibility.

i i The ganglions on the sensitive roots of the nerves.

k A twig of communication between the posterior roots of the two superior spinal nerves.

XI. A spinal nerve, strictly resembling the fifth nerve in its double roots, and its ganglion on the sensitive root.

If we begin our review of this plate by tracing up the columns of the spinal marrow, and observing the origins of the nerves in a regular series, we shall have a distinct conception of the system.

PLATE V.

This figure represents a portion of the base of the brain of Mrs. F., whose case is related at page cxii.

A The left hemisphere of the cerebellum.

B The pons varolii.

C The medulla oblongata.

D A morbid sac, which pressed upon and destroyed the fifth nerve of the left side.

E The fifth nerve, wasted and almost reduced to cellular texture.

PLATE VI.

A VIEW OF THE NERVES OF THE FACE.

In this plate the two distinct classes of nerves which go to the face are represented; the one to bestow sensibility, and the other motion, that is, the motions connected with the respiratory organs.

The nerves on the side of the neck are also represented. These I have discovered to be double nerves, performing two functions; they control the muscular frame, and bestow sensibility on the skin. Besides these regular spinal nerves, which are for the common endowments, the nerves of the throat are represented. These latter nerves are the chords of sympathy which connect the motions of the neck and throat with the motions of the nostrils and lips; not merely in swallowing and during excited respiration, but in the expression of passion, &c.

A The respiratory nerve of the face, or, according to authors, the portio dura of the seventh nerve.

a Branches ascending to the temple and side of the head.

b Branches which supply the eye-lids.

c Branches going to the muscles which move the nostrils.

d Branches going down upon the side of the neck and throat.

e Superficial cervical plexus.

ff Connexions formed with the cervical nerves.

g A nerve to the muscles on the back of the ear.

B The eighth nerve, par vagum, or grand respiratory nerve.
C The superior respiratory nerve, or spinal accessory nerve.
D Ninth nerve, or lingualis.
E Diaphragmatic or phrenic nerve.
F Sympathetic nerve.
G Laryngeal nerve.
H Recurrent laryngeal nerve.
I Glosso-pharyngeal nerve.

I. Frontal nerve: a branch of the ophthalmic division of the fifth.
II. Superior maxillary nerve: a branch of the second division of the fifth.
III. Mandibulo-labralis: a branch of the third division of the fifth.
IV. Temporal branches of the third division of the fifth.
V. Ramus buccinalis-labialis: a branch of the third division of the fifth, prolonged from the motor root.
VI. VII. VIII. IX. Spinal nerves.

PLATE VII.

In this figure the superficial nerves of the face are turned off, and the distribution of the third division of the fifth to the muscles of the jaws and cheek exposed.

A The portio dura of the seventh or respiratory nerve of the face, coming out from the stylomastoid foramen; the principal branches are cut and folded forwards.

B The trunk of the portio dura of the seventh, dissected off the face and pinned out, while it is left at its connexions with the branches of the fifth on the cheek and lips.

C The branch of the third division of the fifth nerve, which joins the plexus of the portio dura before the ear. Some experimenters, ignorant of this junction of a sensitive nerve with the muscular nerve, have occupied themselves with experiments to ascertain the degree of sensibility of the portio dura.

D In this figure the masseter muscle is dissected from the jaw-bone and lifted up to show D, the branch of the fifth pair of nerves going into the muscle.

E The ramus buccinalis-labialis, that branch of the fifth nerve which goes to the buccinator, triangularis, levator labiorum, and orbicularis muscles.

F That branch of the fifth nerve which separating from the mandibulo-labralis goes to the muscles which depress the lower jaw.

G The suborbitary nerve, a branch of the fifth nerve.

H The mandibulo-labralis, a branch of the fifth nerve coming out from the bone to the muscles and integuments of the lip and chin.

I A branch of the fifth nerve descending from the orbit.

D E F are muscular branches of the fifth nerve, and are motor nerves. C G H I are sensitive branches of the same nerve which join the branches of the portia dura in its universal distribution; and although these branches of the fifth enter the muscles, they possess no power over their motions. B is the portio dura, which, though taking the same course with the last, is for a different purpose; while it is a motor nerve it is enabled, by its association with the respiratory nerves, to excite those actions of the face and lips which are necessarily connected with the act of breathing.

PLATE VIII.

Fig. 1. Represents the fifth nerve dissected out and seen on its lower surface.

A The posterior or sensitive root before it forms the ganglion.

B The Gasserian ganglion.

C The anterior or motor root of the nerve passing the ganglion.

D The third or lower maxillary division of the fifth nerve.

E The motor portion joining the lower maxillary nerve and forming a plexus with it. From this plexus go off the muscular nerves to the muscles of the jaw, viz :—

1. Temporalis.
2. Massetericus.
3. Buccinalis-labialis.
4. Pterygoideus.
5. Mylo-hyoideus.

F Division which joins the portio dura.

G Mandibulo-labralis.

H Gustatory nerve.

I The chorda tympani.

Fig. 2. This figure represents the ganglion on one of the spinal nerves, to show its resemblance to the ganglion of the fifth nerve in every particular.

A The posterior or sensitive root of the nerve.

B The ganglion formed upon the posterior root.

C The anterior or motor root of the nerve; this arises in minute branches which join to form the larger subdivisions, whilst the posterior root is composed of simple and abrupt portions. This division joins the sensitive division beyond the ganglion exactly in the same manner that the motor portion of the fifth joins the lower maxillary nerve.

Fig. 3. Represents one of the ganglions of the sympathetic nerve to show how different it is from those on the symmetrical system of nerves. In fig. 1 and 2 the nerve, on entering the ganglion and escaping from it, is separated into branches in a manner very different from the mode in which the sympathetic nerve joins or forms its ganglions*.

PLATE IX.

Fig. 1. Represents the medulla spinalis.

A The pons varolii.

B B The anterior medullary columns of the spinal marrow, continued from the corpora pyramidalia.

C Corpus olivare.

D Corpus restiforme.

1. The origin of the respiratory nerve of the face.

2. Origin of the glosso-pharyngeal nerve.

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* Authors who have treated of the anatomy of the ganglions have not distinguished between the two classes of ganglions as belonging to the sensitive and sympathetic systems of nerves.

3. Origin of the par vagum.

4. Origin of the spinal accessory nerve, or superior respiratory nerve of the trunk.

Fig. 2. Plan of the respiratory nerves in their course through the body.

A The sterno-cleido mastoideus muscle.

B B The trapezius muscle. It is seen to arise from the back of the head, and from the spine; it is inserted into

C The scapula, and

D The clavicle.

E E The serratus magnus anticus. It is left at its attachment to the ribs, but cut off from its insertion into the scapula, so as to expose the trapezius and the spinal accessory nerve.

F The lower surface of the diaphragm.

G The upper surface of the diaphragm.

H The larynx.

The four great muscles (A B B E E F G) are powerful muscles of inspiration.

To simplify this view, the regular or symmetrical system of nerves is not presented in this drawing, but only the respiratory nerves. It is the entwining of nerves of distinct systems which produces the apparent intricacy. If the spinal nerves were represented crossing these, and the network of the sympathetic superadded to them, we should have all the seeming confusion of the dissected body.

1. Respiratory nerve of the face, or portio dura of authors.

2. The glosso-pharyngeal nerve.

3. The superior respiratory nerve. It is seen to pass through the sterno-cleido mastoideus muscle, and to supply it with branches; then to take a course down the side of the neck, branching exclusively to the trapezius muscle.

4. The phrenic or diaphragmatic nerve. It is seen coming out from the spine, and running a direct course to the diaphragm.

5. The external respiratory nerve of the chest. It is like the last nerve in its origin, but it deviates in its course, passes on the outside of

the chest to supply the powerful respiratory muscle, the serratus magnus E E.

These three nerves with the par vagum combine the sterno-cleido mastoideus, the trapezius, the serratus magnus, and the diaphragm, with the lungs, the larynx, the tongue, and nostrils.

6, 7. The nerve of the par vagum. Coming from the same origin with the other respiratory nerves, it passes down to the internal organs; but in its passage gives off these:—

8. The superior laryngeal nerve, a branch of the last nerve.

9. The recurrent nerve; a branch also of the par vagum. Where the par vagum is in the thorax (7) at the same time that it sends off the recurrent (9), it sends off many small nerves to the heart and the lungs, and then descends in a plexus on the œsophagus, to the stomach.

THE END.

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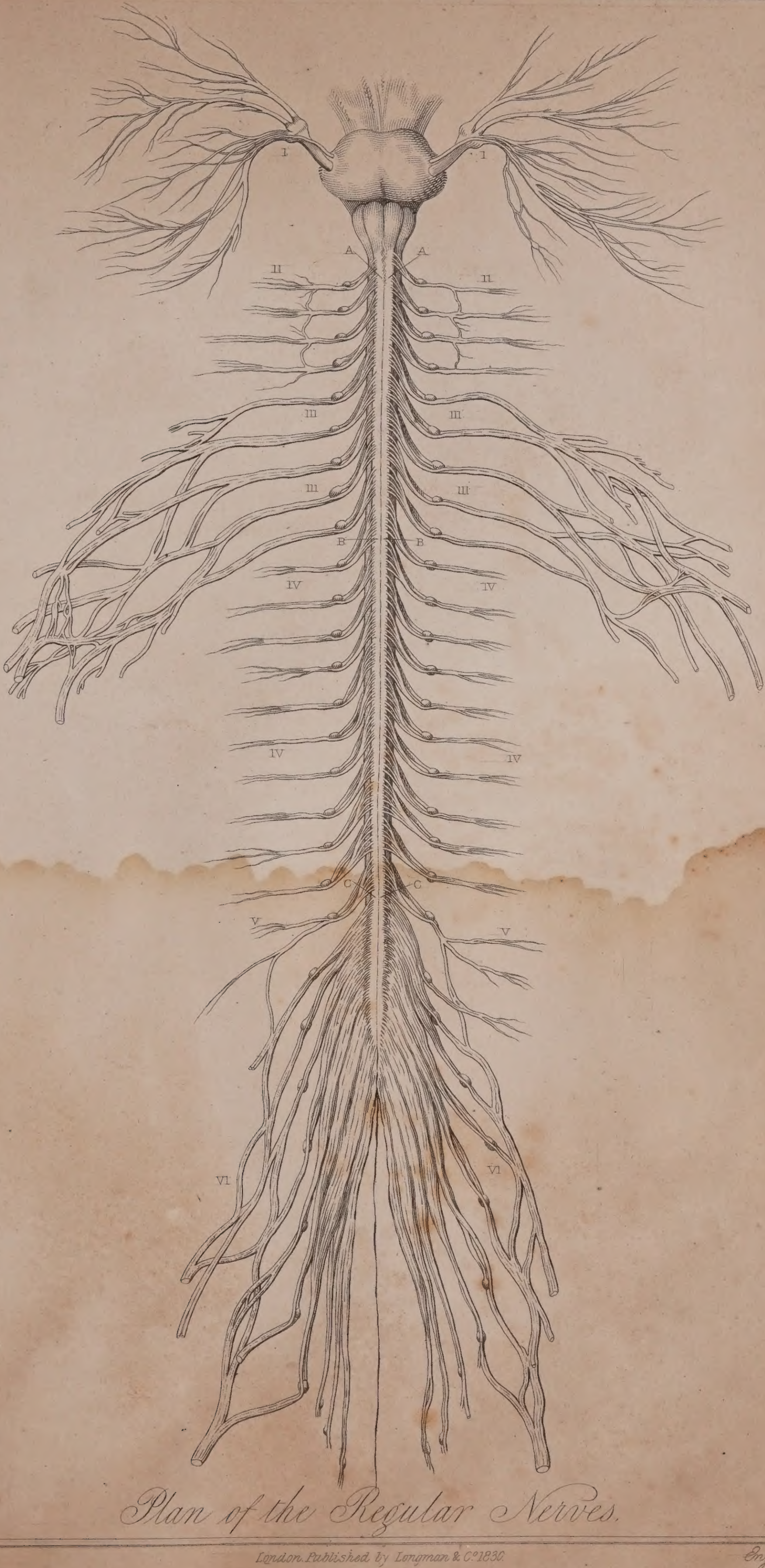
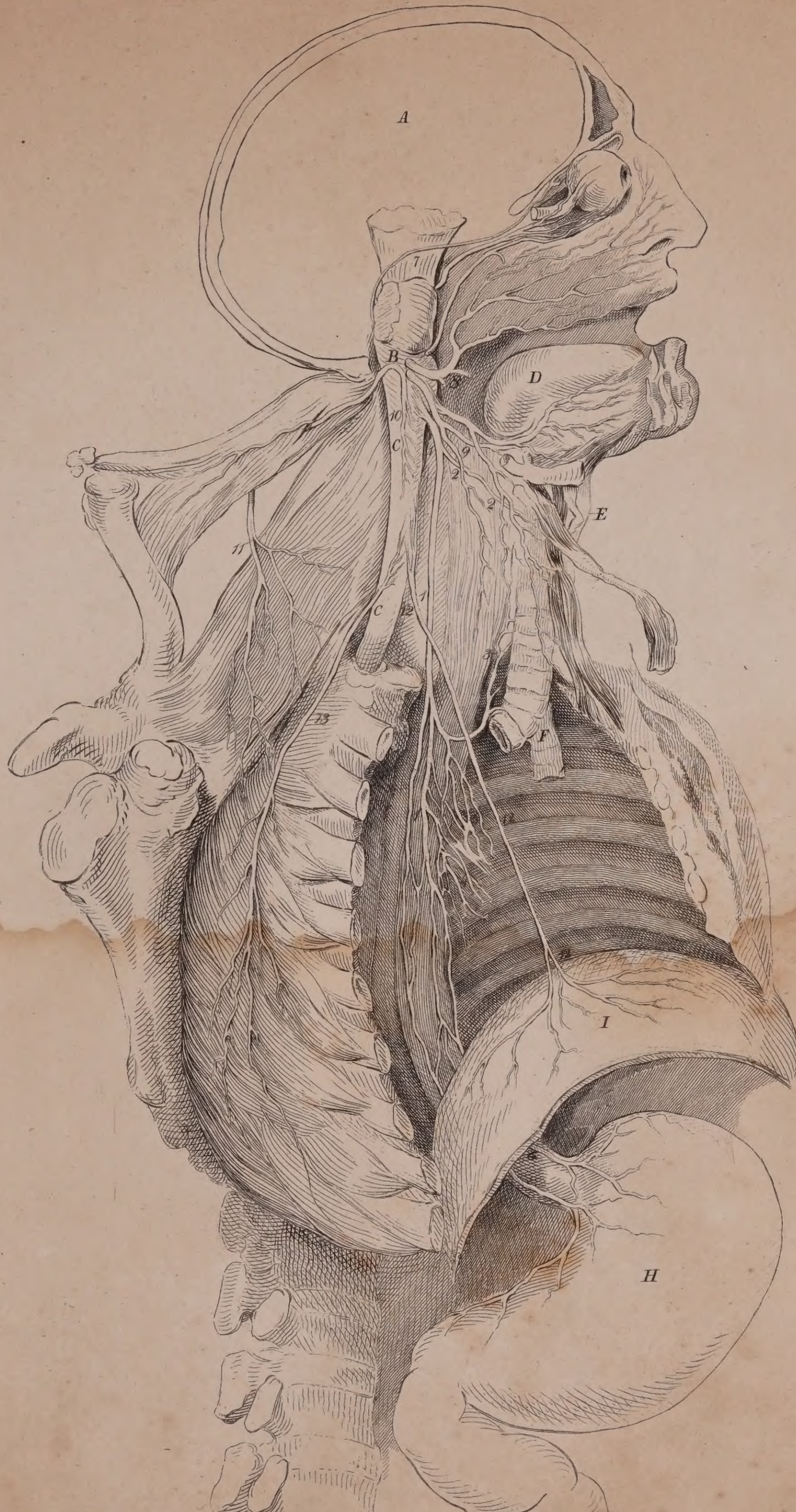
PLATE I.



Plan of the Regular Nerves.

Drawn by C. Bell. London. Published by Longman & Co 1830. Engraved by J. Stewart.

PLATE 11.



Plan of the Irregular Nerves.

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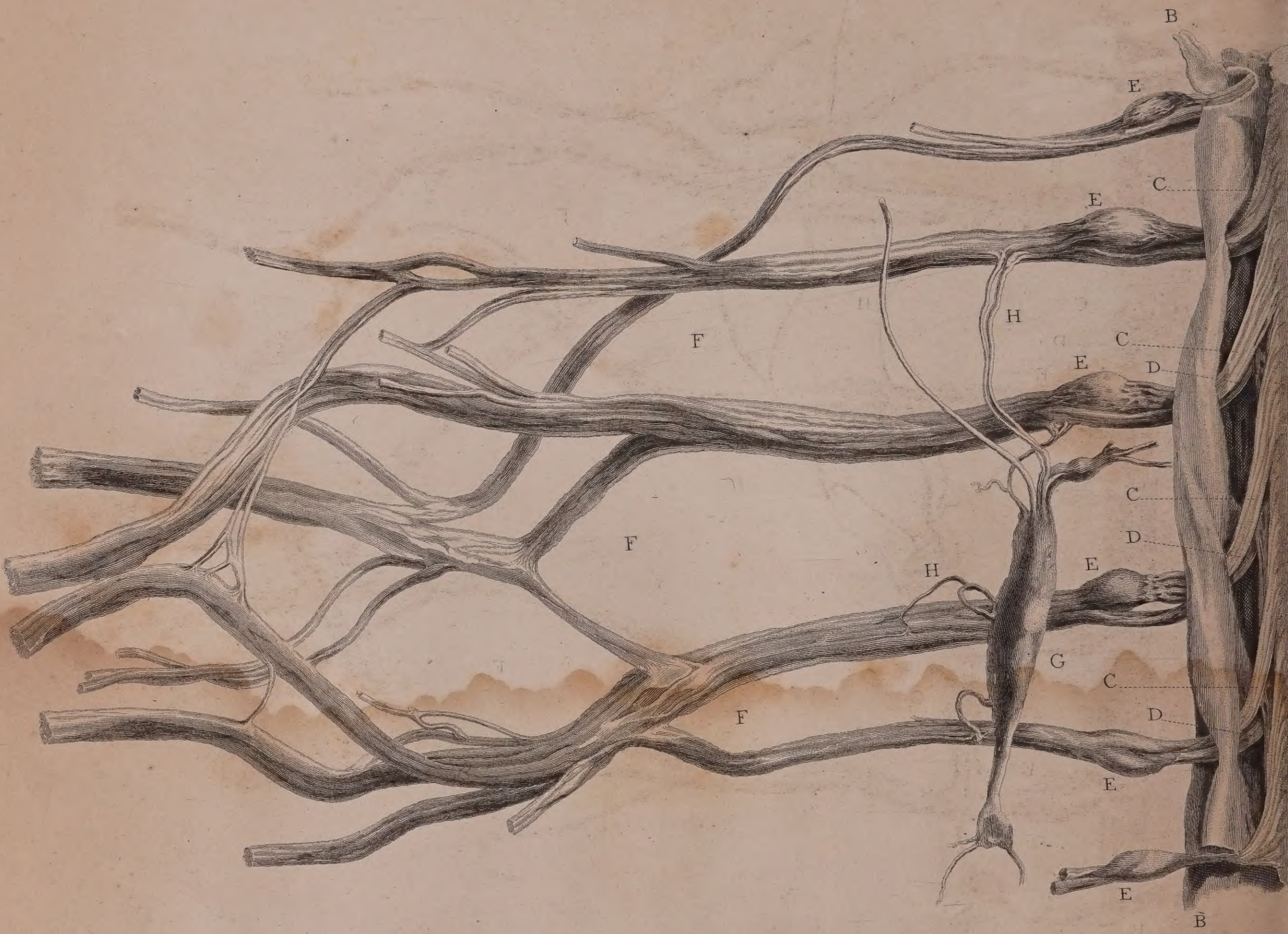
Plate III.



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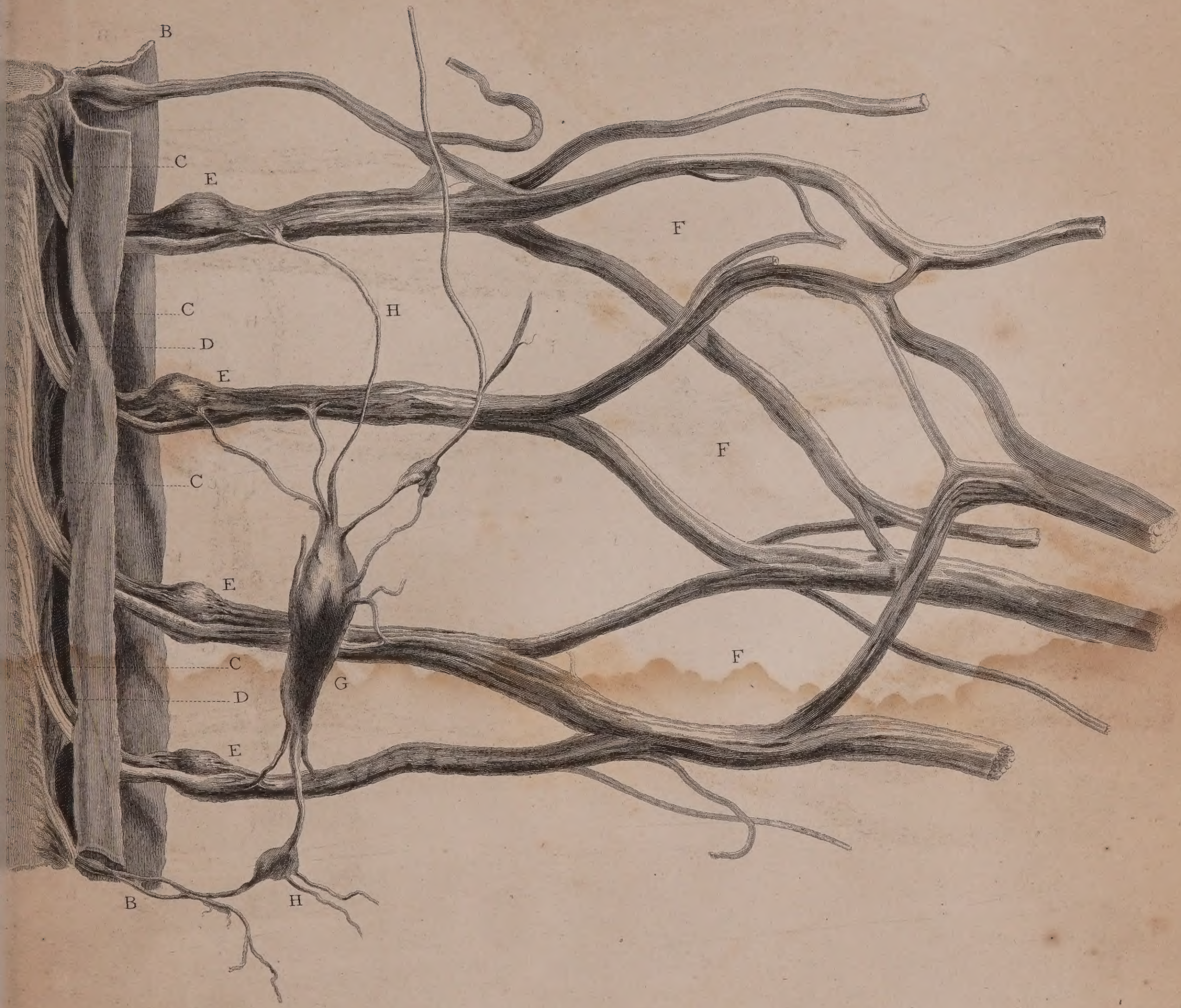

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PLATE IV.

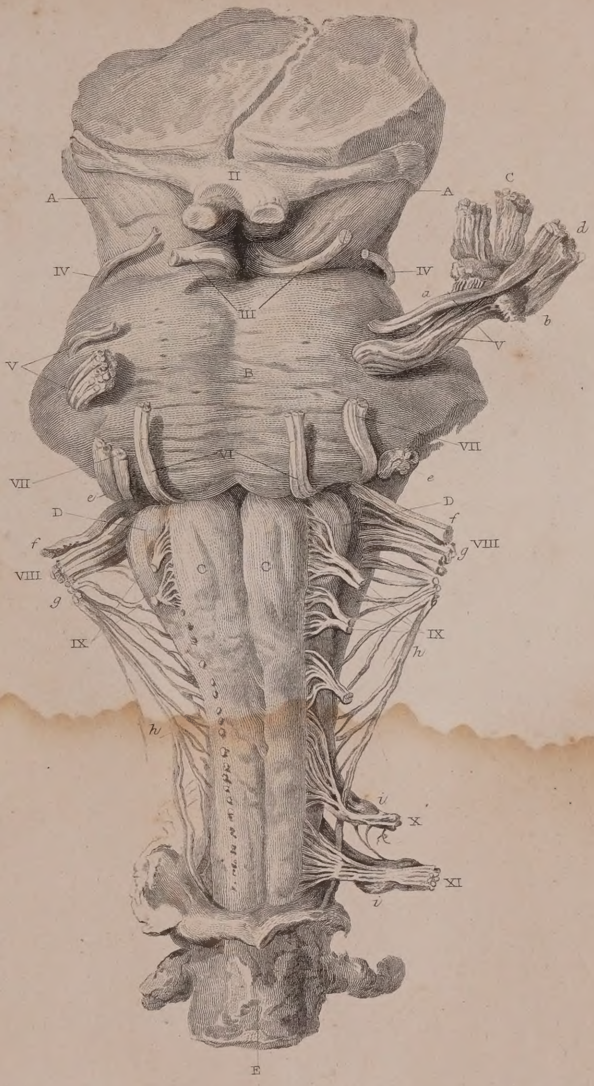

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PLATE V.

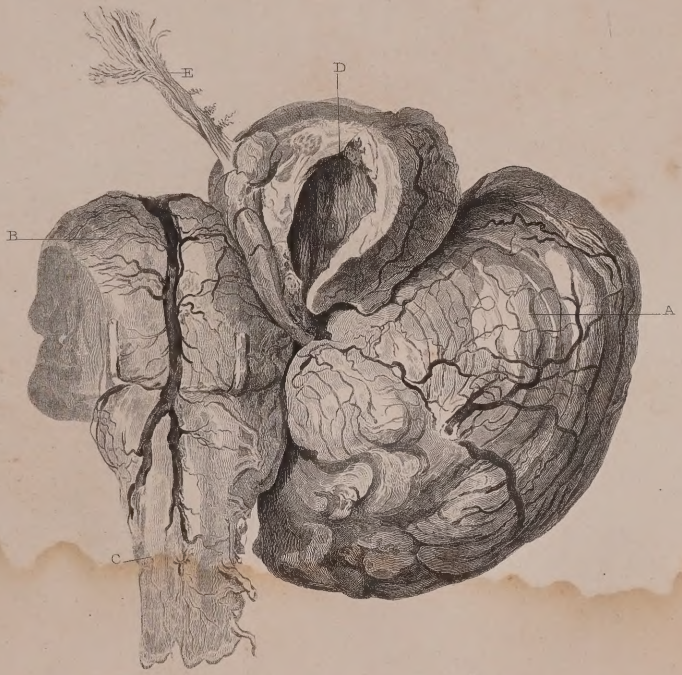

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PLATE VI.

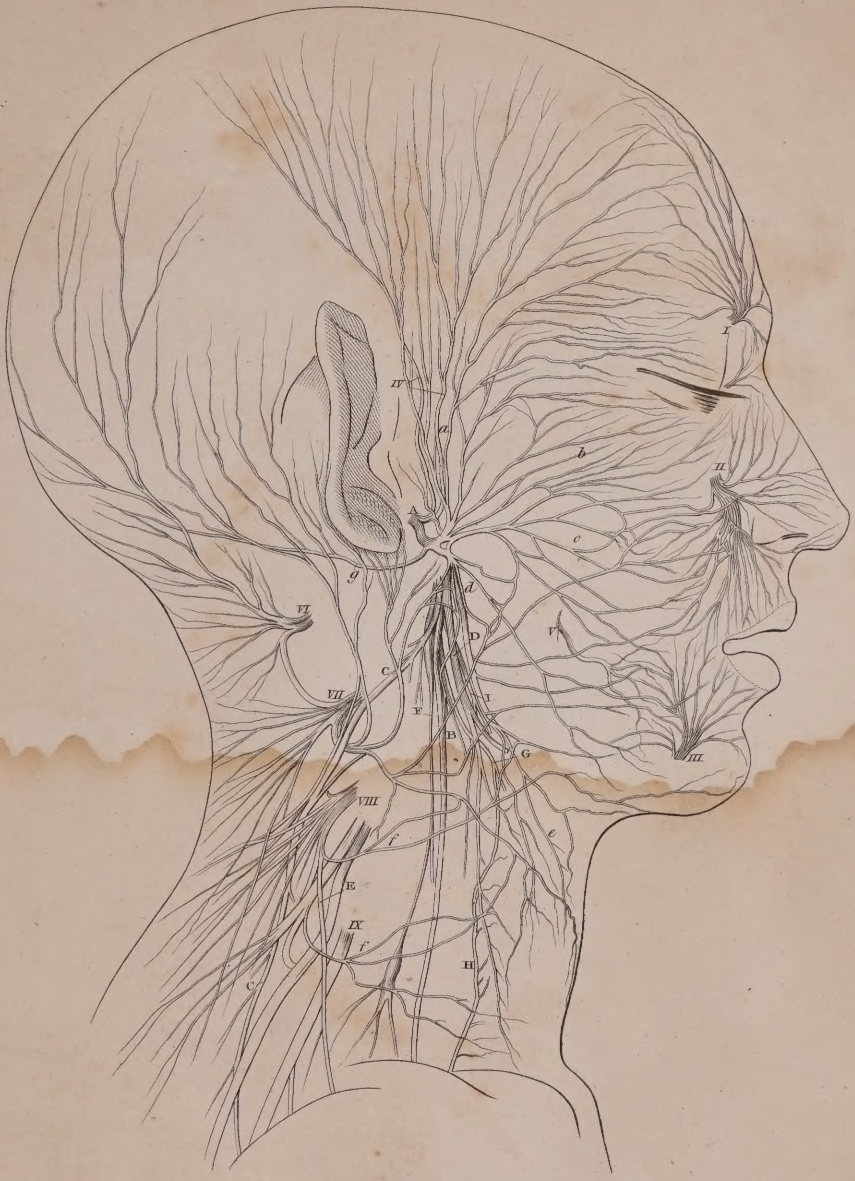

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Plate VIII.

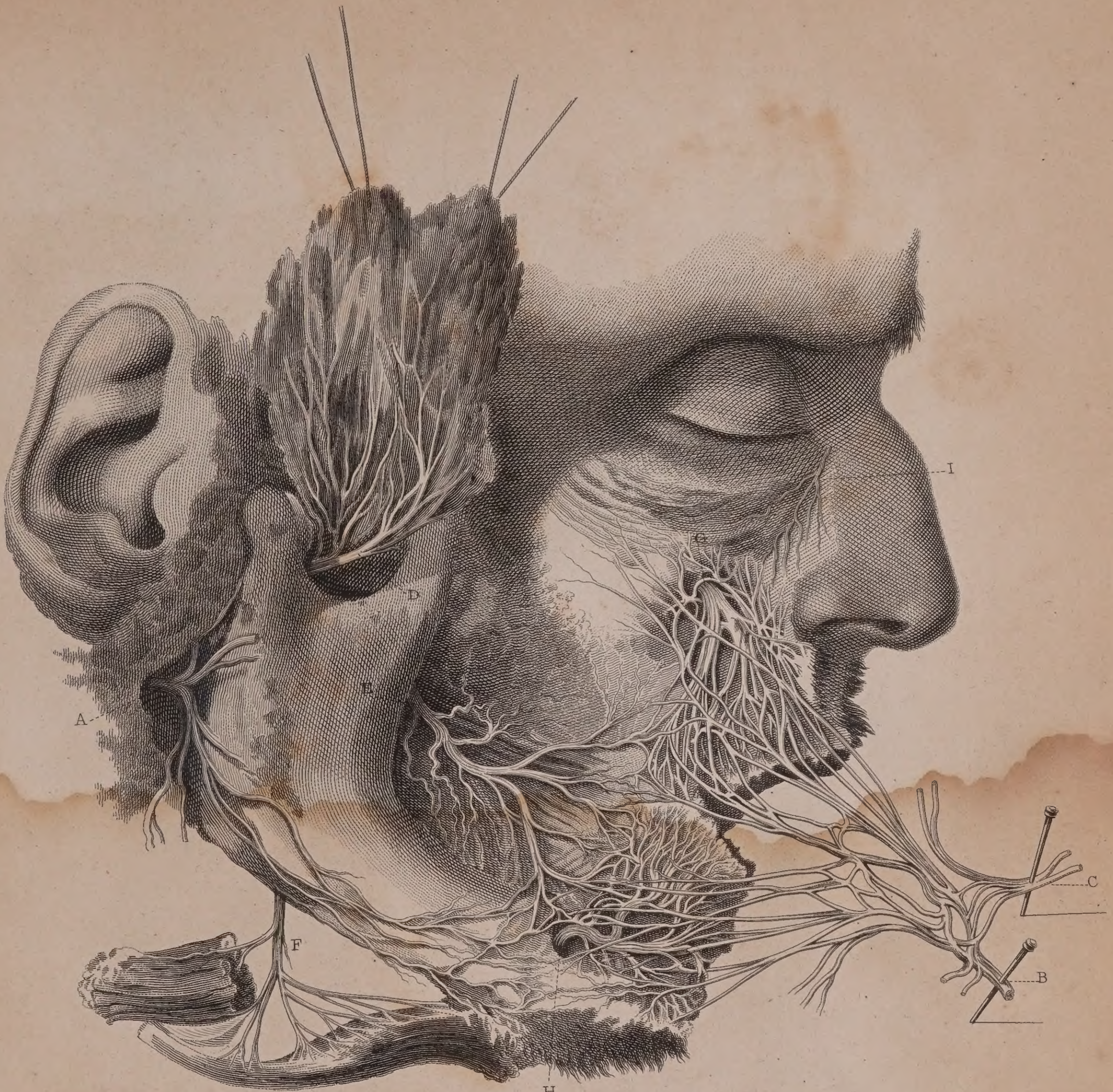

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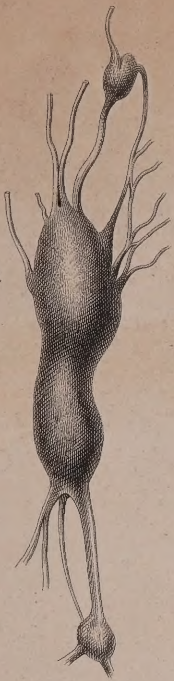
Plate VIII.

Fig. 3.



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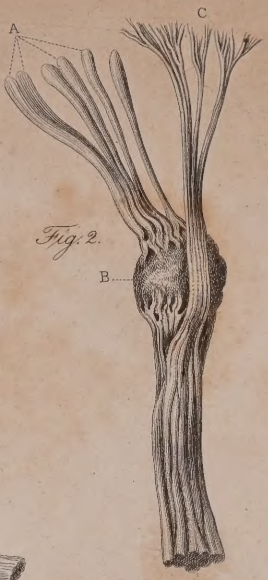

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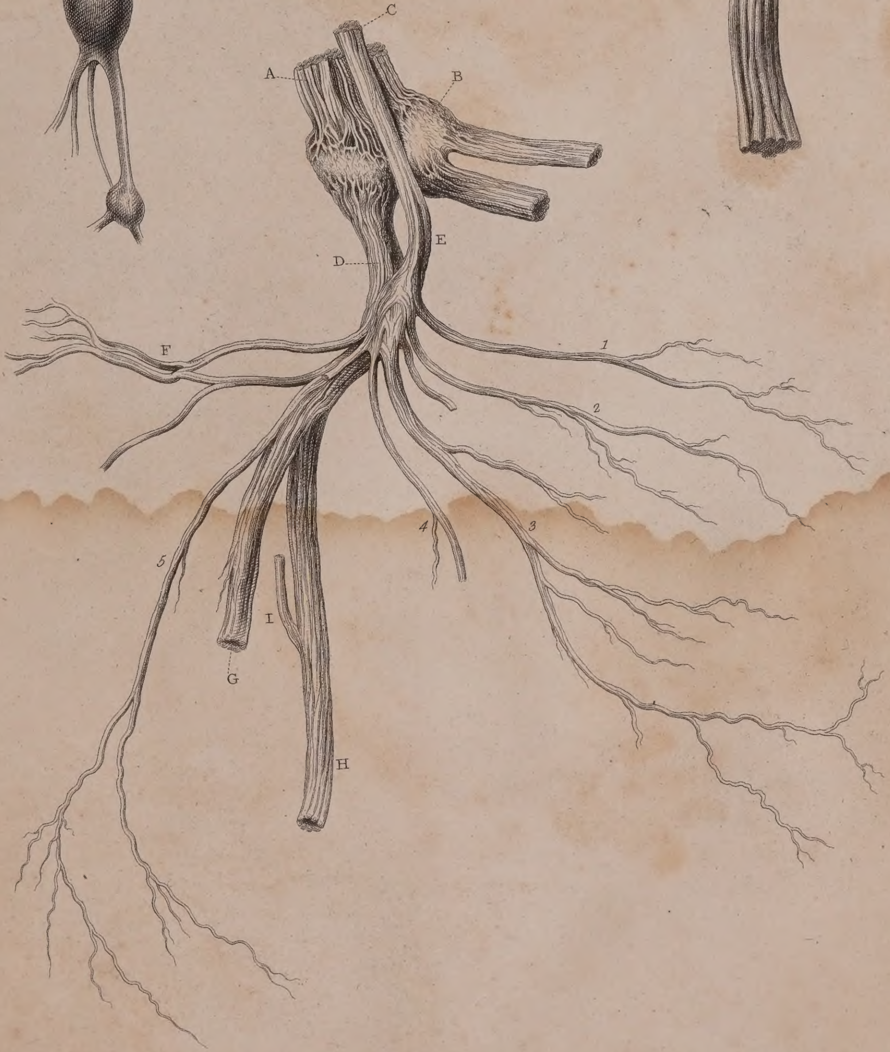

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Plate IX.

Fig. 1.

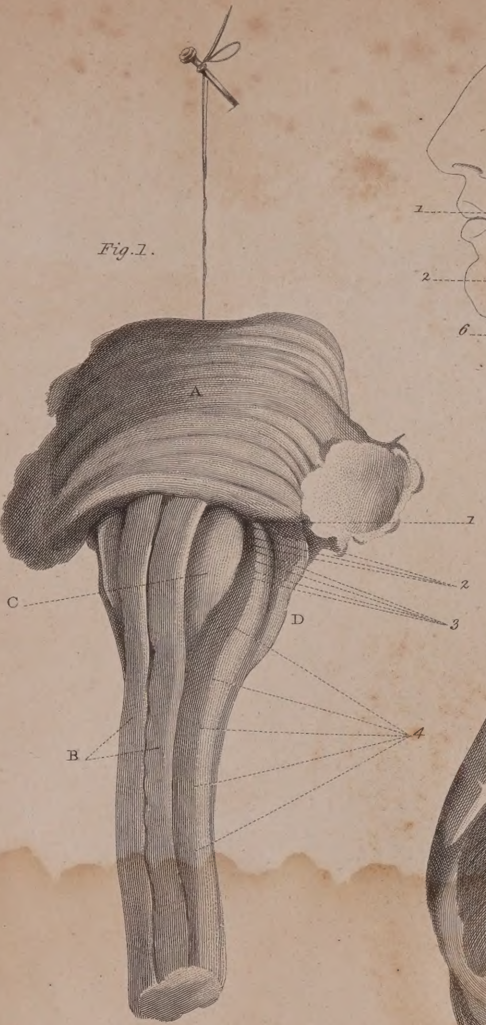
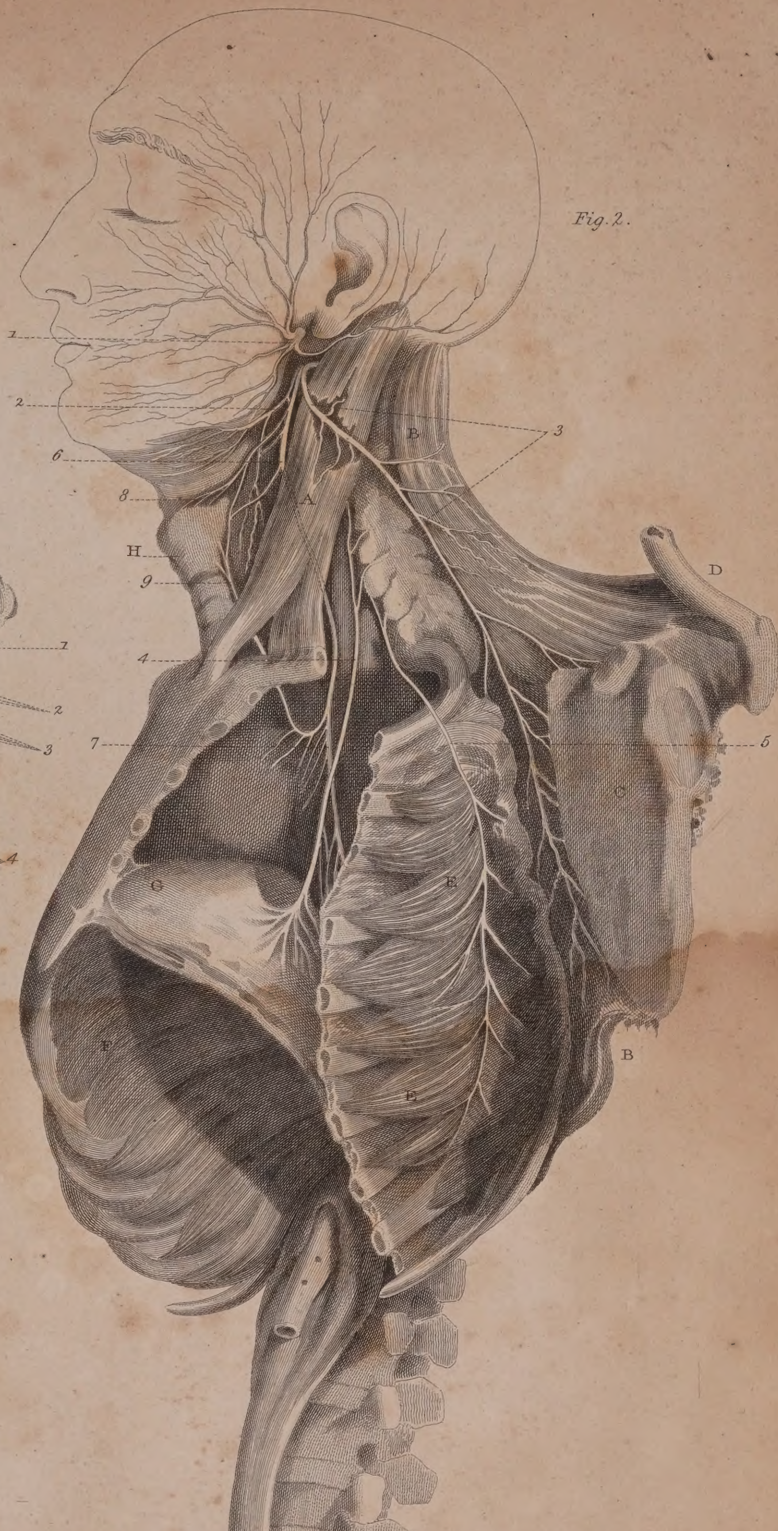


Fig. 2.



Charles Bell del.t

J.o Basire sculp.t

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